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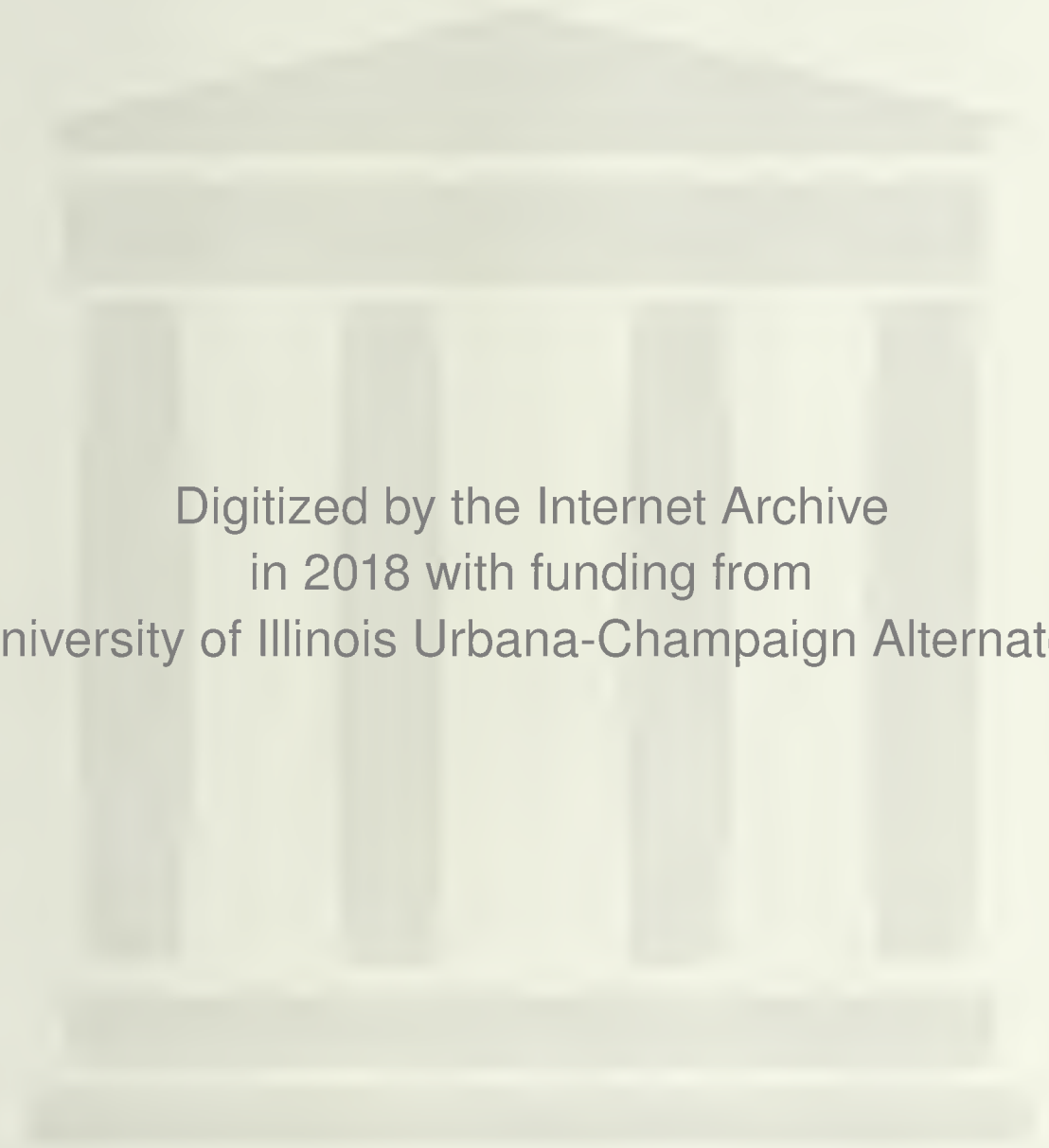

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CHURCH SCHOOL—BOSTON

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TOWNSHIP LAYOUT

By

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FOREWORD

From the beginning of the present century public interest has been more and more focused upon Town Planning as offering a possible solution of some of the problems that have arisen out of the increasing urbanisation of the populations of rapidly developing countries. This public interest, which has been stimulated by the need for post-war reconstruction, has created a demand for literature on Town Planning and the student of the subject now has an almost embarrassingly extensive bibliography at his disposal. Not many of the published works on Town Planning are however suited to the requirements of an inexperienced planner who, if called upon to plan the development of a small town or an extension of an existing town, must find the answers to questions of fundamental importance such as those relating to types of road-pattern, size of plot and number and size of sites for business and other purposes, together with a host of other matters which must be settled before he can begin his task.

Planners in South Africa are faced with problems which do not arise in other countries and the information they require in connection with the planning of towns is not, so far as I am aware, contained in any existing textbook on Town Planning. It is possibly because of the lack of an authoritative work on urban development in South Africa that the planning of so many of our towns has been stereotyped and uninspiring. A textbook having special reference to South African conditions will supply a real need.

The Author is well equipped for the task of preparing a practical handbook on the subject of township layout. He has had wide experience in municipal engineering and has dealt extensively with the preparation and administration of Town Planning Schemes, both as an official and in the capacity of a professional consultant. His close association with the Transvaal Townships Board, as a member of the firm which acts as Technical Adviser to the Board, has also given him an insight into some of the difficulties with which the Provincial Administration is faced as the result of deficient or faulty planning in the past. I consider that Mr. Floyd has accomplished his task with pronounced success, and I count it an honour and a privilege to be given the opportunity of welcoming the publication of this book.

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PREFACE

Much has already been written in many countries on the subject of site-planning but, although the fundamental principles of site-planning remain the same for all countries, it is essential to adapt the application of these principles to national conditions.

To do this successfully requires experience and a thorough knowledge of such conditions. It may be said that much found in overseas books and journals is unsuitable for South African conditions. The system of registration of the ownership of land, the custom of erection of single-storey houses with servants' quarters in the back yard, the individualistic and rural or semi-rural character of the majority of South African people, the variety of races and climatic conditions are all factors which render much of what is done in other countries inapplicable here.

At present there are no books in existence which deal with township development peculiar to South African conditions and the needs of our country.

Many persons engaged in township development work or who are teaching or studying the subject have on various occasions expressed their need for such a work to the author. It is the expression of this need that has encouraged the author to undertake the task of writing this volume.

Practical examples are quoted in most instances and an attempt has been made to deal with the numerous problems which may arise when a layout plan is prepared. With this end in view township development has been treated fully and the illustrations have been chosen to give examples of a variety of sites and layouts. Problems on the layout of small holdings and native locations have been included.

In concluding these remarks the author wishes to express his gratitude to all those who have assisted him by granting the permission for the reproduction of plans and photographs.

Particularly does the author wish to thank Col. P. J. Bowling, M.T.P.I., F.R.I.C.S., M.I.Struct.E., Mr. C. S. Douglas, B.A.(Hons.), A.M.I.C.E., Mr. N. Cooper, Land Survey Diploma, M.T.P.I., and Mr. K. Richardson, A.M.T.P.I., M.I.A. for reading the manuscript and for the suggestions made by them.

T. B. FLOYD.

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Chapter I

PRELIMINARY SURVEY AND CONSIDERATIONS

1. Choice of Site
2. Topographical Survey
3. Financial Considerations

1—CHOICE OF SITE

Seldom is a town planner given a free choice of site. Usually the site has already been selected and purchased by the land developer prior to the engagement of a town planner. Better results would be obtained if experienced town planners and civil engineers were engaged before any land is purchased.

In some instances, as in the case of the planning of a new town, the site is determined by existing development, which may consist of a small group of houses and shops at the railway station or it may be a small village at some other point of concentration of persons such as a cross-roads, church or school. In other cases the site is fixed to some extent by the establishment of a large industry or mine and the land is often purchased predominantly to suit the needs of the industry. Additional area is then added to that required for the predominant use and on this area the town must be planned.

When dealing with a residential suburb or extension to an existing town the selection of the site is not, as a rule, technically very complicated. The problem then predominantly resolves itself into a question of anticipating public demand for building sites. Many speculative land developers possess an almost uncanny intuition in the selection of an area that will provide such sites.

The problems connected with the sites of new towns are far more in number and difficult to solve than in the case of suburban sites. Long technical experience is required before a good selection is possible.

The choice of a site for a new town may be considered similar to the case of engineering works such as dams, main roads and railways where only experienced and trained civil engineers can satisfactorily select the site or route. In all these cases the choice of site is very important and more complex than the later design, construction and development that follows.

On the examination of many towns it is often found that their sites are near to but not in the best positions. This indicates a failure on the part of the selectors to fully appreciate the factors, problems and difficulties involved.

Should an opportunity occur to freely decide on a site for a township, any choice made is dependent on the following :—

(*a*) topography and nature of the soil,

(*b*) character of development *i.e.* residential, industrial, suburb or new town,

(*c*) distance from town centre, from other towns or in the case of industrial townships, from residential areas,

(*d*) water supply, electricity and other essential services,

(*e*) probable demand for building sites,

(*f*) the economic or employment group for which the township will cater,

(*g*) shape of area.

(*a*) *Topography and Nature of the Soil.*—The nature of the land should of course be such that the site is healthy ; swampy or bleak land should be immediately eliminated from any further consideration for residential development. Soil and sub-soil must be considered from a building as well as a garden aspect. Clay soils are unsatisfactory for building foundations and rocky sites are not suitable for agricultural holdings nor are they satisfactory for residential development into small erven.

If the proposed development is the establishment of a new town a slightly sloping site is required. Steeply sloping land, rough broken sites with rocky ridges or water courses are unsuitable for such a purpose.

Flat land is required where the industrial area of any such new town may be located and beyond this there should be slightly sloping land suitable for a native location.

A proportion of rough broken ground may be included provided it is a little distance from the proposed centre. Such land may be developed residentially for large erven, parks and open spaces. Areas of this type may add beauty and individuality to a town.

To facilitate drainage and sewerage works the whole site and any probable extensions should all fall into one watershed.

(*b*) *Character of Development.*—Before proceeding to develop any site an investigation should be carried out in order to ascertain the probable demand for erven and the character of the township to be embarked upon. The place of employment, as well as educational, transport and other facilities are all matters to be considered when such an investigation is made. Trends of development of adjacent or nearby areas should also be studied.

People of the lower income groups sometimes seek large sites where the soil is good and gardening may be undertaken. More

often, however, persons of these groups seek small erven because of the lower capital and upkeep costs. Much depends on the system of rating, amount of rates payable, the charges for water and the rainfall of the locality. Fashion plays a part in the popularity of certain localities for the higher income groups.

With many persons the position of schools and churches is an important factor in the development of a suburban area, near or in a city.

Around large cities particularly, one finds a preference for certain areas among the various income groups.

It may therefore be advisable when investigating the possibilities of a site to first study the demand for a certain size or type of erf and then seek out suitable land for such class of development. Alternatively the site may first be purchased and then a study made of how to develop it to best advantage. This will work out satisfactorily when there is a large general demand for erven of all types, but would not prove successful where the demand is restricted to certain classes of erven only.

Undulating and slightly sloping land is most suitable for development into any size of erven. For small erven this is the only type of site that proves satisfactory. Steeply sloping and broken country can only be economically developed for large erven suited to the wealthier class of purchaser.

The less a site slopes the cheaper will be the building and development costs. Very flat sites, however, are difficult to provide with drainage works and for this reason may better sometimes be developed into large erven.

(*c*) *Distance from Town Centre, or other Towns.*—The distance factor is not necessarily a given number of miles, but is largely a relative one. For suburban development three miles may be considered too far from the centre of a small town, but in the case of a large city even eight miles may not be thought too far off.

A rough guide as to distance is to regard half-a-mile beyond existing partly built up areas as a maximum for small town suburbs. In the case of a city or large town the time factor should be taken as a guide. This should not exceed forty minutes by public transport from the place of residence to place of work and should preferably be within thirty minutes. Note that in this case the place of employment and not the city centre should be considered.

The time factor will vary with distance, means of public transport, *i.e.* bus, tram or train, and the hindrances such as frequent stops, traffic congestion, etc., which the public transport encounters en route. The walking time at each end of the transport service must also be taken into account in the time-distance.

In a small market town the town centre is usually the chief place of employment, but in the case of a mining or industrial one there may be two or more centres of employment. Small residential towns are in this respect similar to suburbs.

No new market town is likely to develop if too close to an existing one. The term " too close " is used in a relative sense and depends on the density of population which the district is able to carry. It may differ from 10–15 miles in districts of intensive farming such as in the Western Cape or Boland and 50–100 miles in pastoral areas such as the Karroo or North-Western Cape.

New towns, which are pleasure resorts, mining towns or towns based on some large industrial development may successfully grow up quite close to an existing town. This is seen on the Reef where mining towns are 5–6 miles apart, centre to centre, and where many municipal boundaries are common to two or more towns.

(*d*) *Water Supply, Electricity and other Essential Services.*—Water, sanitation and electricity are the most essential services for building development. It should be possible to conveniently dispose of waste products in an hygenic manner if a township is to develop properly.

Where erven are an acre or more in extent and the soil is easily drained each building site is able to take care of most of its own wastes. For this reason it is often economical to plan a new site with acre erven, but in doing this, provision should be made for later subdivision into smaller building sites. This means that parks, open spaces, school sites and sites for public buildings must be provided on the basis of the ultimate population. A plan of subdivision should be prepared beforehand and all owners bound to follow such plan when subdividing later on.

No township should be allowed unless provision is made for the most necessary services such as water supply and night soil removal or sewerage. Other services needed to make a success of any township are trafficable streets, good road access to the site and good transport.

(*e*) *The Probable Demand for Building Sites.*—In township development there are two forms of demand for building sites, *i.e.* the speculative and the real.

The township developer thinking in terms of sales is little concerned which of the demands there is as long as a demand exists. Many establised land development companies that take a longer view are somewhat concerned as they wish to see the townships they promote develop and not lie unoccupied.

Often the speculative demand outruns the real demand by as much as twenty to thirty years. This means that it may easily be many times the real demand. The speculative demand comes from people who buy land and let it lie idle hoping to sell later at a higher price or merely following an urge to own land. This urge to own land is very strong in South Africa. People who wish to occupy and use the land within a short space of time create the real demand.

It is very hard to assess the demand for erven. Estate agents and municipal departments may give some indication and so may the number of vacant erven or lack of such. These indications must

all be studied together with growth possibilities and the occupation and wages of the population. Usually it is found that the general public have wild and extravagant ideas of growth possibilities and this has a great bearing on the speculative demand. The fact that a large number of vacant erven exist in any area does not necessarily mean that there is no demand because such erven may be of the wrong size or in the wrong locality to meet an existing demand.

(*f*) *The Economic or Employment Group for which the Township will cater.*—The situation and the size of the erven are both determined by the group that must be catered for. Local shopping centres need to be larger in townships where weekly paid tradespeople live than in those of the higher income groups. There is also need for the provision for workshop areas in such townships.

(*g*) *Shape of the Area.*—This is an important factor which has a great bearing on the layout design. Difficult shapes make for unsatisfactory layouts and although some fair solution may be found by a skilled planner where a suburban township is designed, it is quite impossible to plan a satisfactory layout for a new town on a badly shaped site.

It is often difficult to overcome the handicap of an awkwardly shaped piece of land except by adding more land to it and this is not often practicable or possible. Many of these bad shapes have been created for very sound reasons when the land is used agriculturally, but these reasons have seldom any meaning when the land is developed for township purposes.

2. TOPOGRAPHICAL SURVEY

Once the site for a township is selected a topographical map or plan should be prepared. This work is usually done with the tacheometer and carried out generally by land surveyors and civil engineers.

All rocky outcrops, krantzes, ridges, hill features, rivers, streams, spruits, groups of trees, roads, cart tracks, electric lines, buildings, fences, structures, holes, excavations, ploughed lands and stony patches should be picked up and plotted on the map. Contours should be at 5ft. vertical intervals and where the ground is not an even slope, spot levels are necessary in order to show clearly where changes of grade take place.

Before the survey is made trial holes 4ft. deep, or until rock is exposed if less than 4ft., should be dug at intervals in order to examine the depth of soil. These trial holes should then be picked up when the survey is made and their positions plotted on the topographical map.

It is essential, although at present seldom done, to survey beyond the boundaries of the site to be planned and to indicate on the plan any topographical features of importance as well as contours for

this surrounding area. The distance beyond the boundary depends on the site and the swing of contours. Particular attention should be given to features which may influence the route of streets or roads.

Where any site is very broken and steep resulting in some proposed roads in a layout design having steep grades and heavy cross-falls, it is necessary that the alignment of such roads should be pegged out and levels taken. From these levels longitudinal and cross-sections should be plotted and the cut and fill clearly shown on them. At present the Townships Boards do not require such sections, but it is considered that they certainly should do so.

3. FINANCIAL CONSIDERATIONS

There are many financial implications which a land developer must very carefully consider before embarking on a new township. These are as follows :—

(*a*) cost of land;

(*b*) loss of land in roads, open spaces, school sites, sites for government purposes, sites for municipal and other public purposes;

(*c*) rates;

(*d*) fees for town planner, land surveyor, attorney and engineer;

(*e*) cost of water and electricity supply and reticulation;

(*f*) forming and grading of roads, construction of culverts, bridges, stormwater and other incidental work;

(*g*) endowment;

(*h*) Townships Board and advertising costs, agents commissions and fees;

(*i*) and compound interest on capital invested until wiped out by sale of erven.

The above are the matters to be taken into account when a township is a suburban one, but if a new town is established land should also be provided for cemeteries, native location, municipal activities, large open spaces, recreation grounds and commonage, as well as disposal sites for refuse, nightsoil or sewage. In the Transvaal the Townships Board insists on a satisfactory provision of parks and open spaces. The area is laid down in town planning schemes and where such schemes are in operation they should be consulted. A fair proportion of open space for the township developer to provide is that needed for local parks and playgrounds and should be about three acres per thousand of population. This basis has been used in many town planning schemes and worked out to a percentage of the township area varying with the minimum size of erf laid down.

The following is a scale used in many Schemes :—

Density Zone	Percentage of Area
5,000 sq. ft. per dwelling	6·0
Over 5,000 sq. ft. and up to 7,000 sq. ft. per dwelling	4·5
Over 7,000 sq. ft. and up to 8,000 sq. ft. per dwelling	4·0
Over 8,000 sq. ft. and up to 10,000 sq. ft. per dwelling	3·0
Over 10,000 sq. ft. and up to 12,500 sq. ft. per dwelling	2·5
Over 12,500 sq. ft. and up to 15,000 sq. ft. per dwelling	2·0
Over 15,000 sq. ft. and up to 20,000 sq. ft. per dwelling and higher	1·5

In addition to the provision of the necessary sites the actual waterworks, sewerage works and other undertakings may have to be embarked upon.

Tables A, B and C* at the end of this chapter are a guide as to the area of roads, open spaces and school sites that must be allowed for in surburban townships. The length of road per erf is also given.

At present the basis of assessing the school sites required in the Transvaal is far too liberal and results in more sites being provided than will ever be required. A sounder basis would be to work on 450 erven per school. The full size primary school site should not be less than three morgen,† although it is the practice to request two morgen in the Transvaal.

The Townships Board of the Transvaal will not approve of any township unless the water supply is brought to the site and reticulated to every erf when sold. The full cost of this water reticulation system must be borne by the township owner.

The same conditions apply to electricity, where available, except that the capital expenditure of this service is refunded later by the local authority.

When considering the amount of endowment to be paid on the present method of assessment it must not be forgotten that the cost of water reticulation adds to the sale price of the erven and therefore also adds to the amount of endowment to be paid.

It has been contended by many persons, particularly municipal officials, that the township owner should be obliged to provide all services such as road construction, storm-water drainage and sewerage, as well as water reticulation. The idea behind this is that the land developer should carry the burden and not the ratepayers at large. This of course would not in any case result as the township owner would merely add these costs to the cost of the erven and the purchaser of same would pay.

The purchaser however would not only pay these costs but would also pay a percentage profit, agents' fees and interest on

* The Transvaal requirements are quoted for these provide the best standards.
† 1 Morgen = 2⅛ English Acres.

capital added to such costs. Such a procedure would result in much capital expenditure being incurred before there was any need for the works and this would unnecessarily increase the cost of erven and would result in a great amount of wasteful expenditure.

This scheme is therefore unsound and it is contended that only water and electricity reticulation as now required by the Transvaal Townships Board should be carried out by land developers. The first of these services is essential to health and both are necessary to the sale of land.

Should municipal officials not wish to burden the ratepayers generally with the cost of services to new townships, a remedy may be found in differential rating or special assessment. It is, however, more complicated than this for do not the water charges include for repayment of loans for pipe reticulation in existing areas ? The new areas may therefore help to pay for the expenditure in older ones. They also bring more customers to the shops in the existing central shopping area and thus raise the rateable value of such shops thereby increasing the rates from these.

The endowment paid by township owners is intended to assist towards many of the amenities and services provided for their township, but at present it is assessed in a crude and grossly unfair manner. It is an apparently simple method to fix endowment at 10%, 12% or some other percentage of the sale prices of erven but such sale price has no relation at all to the cost of essential amenities and services such as roads, sewers, etc.

The present method of assessment of endowment would mean that an owner would pay more on a given area of land if it is economically and well laid out than where it is wastefully designed with greater road length and area as well as less erven. This is in spite of the cost of services and amenities being greater in the latter case.

Another fact to consider in this connection is that the more amenities a land developer provides, the greater will be the sale price of erven and the larger the amount to be paid in endowment.

If a simple method is desired for the assessment of endowment no better basis than the length of roads is obtainable. The amount must, however, not be a standard one per mile but must vary according to nature of site and subsoil just as the percentage of endowment is at present varied.

Road length is a good unit of measurement because water mains, sewers, stormwater drains and electric lines are all related and in proportion to road length. The only exception being when road bays are used to any considerable extent.

The time taken to bring a township from the stage of the purchase of the site to that of selling the erven has an important bearing on the compound interest cost factor. The period required is usually from 18 months to 2½ years. It is best to estimate on two years.

Another factor affecting compound interest on capital invested is the time taken to dispose of the erven in any new township. This time will of course depend on how ripe for building development the

land is. An attractive and well designed plan with a liberal provision of public open spaces will have a marked bearing on the rate of sales.

Should the land have been purchased wisely and with due caution ten years may be taken as an average to dispose of the erven. Many townships have taken over thirty years to sell out whilst others have achieved this in three years.

It must not be overlooked that as soon as a township is finally approved rates must be paid to the local authority in whose area it is situated.

Many township developers are averse to the provision of parks and public open spaces for they regard these as so much land given away or lost. This is a wrong outlook. The provision of an ample amount of parks and open spaces will mean no loss at all because the surrounding erven increase in value in many cases proportionately more than the value of the land used for such parks.

TABLE A.

Approximate Percentage Areas of roads, open spaces and school sites for various sizes of erven.

Size of Erven in Square Feet	Percentage Area of Open Space	Percentage Area of Roads	Percentage Area of School Sites	Total Percentage of Area Lost
5,000	6·0	26	8·2	40·2
7,000	4·5	26	6·2	36·7
10,000	3·0	23	4·8	30·8
15,000	2·0	21	3.4	26·4
20,000	1·5	18	2·7	22·2
40,000	1·5	15	1·4	17·9

Note.—The above table is for unbroken flat or slightly sloping sites. In the case of broken land with rough hills and valleys and streams the amount of open space may double and the percentage of roads also somewhat increase.

The percentage of open space is the minimum requirement and something more than this should be provided in a good township.

TABLE B.

Percentage of Street Area to Total Area.

Street Width in Ft.	Depth of Erf in Feet									
	50	75	100	120	150	180	200	220	250	300
30	26·7	20·6	17·2	15·3	13·4	12·1	11·4	10·8	10·2	9·3
40	33·0	26·0	21·9	19·6	17·3	15·6	14·8	14·1	13·2	12·1
50	38·5	30·8	26·2	23·6	20·9	18·9	17·9	16·9	16·1	14·8
60	43·2	35·1	30·1	27·3	24·2	22·1	20·9	20·0	18·8	17·4
70	47·3	38·9	33·7	30·7	27·4	25·0	23·8	22·7	21·4	19·8
80	51·0	42·4	37·0	33·9	30·3	27·8	26·5	25·3	23·9	22·1
90	54·2	45·7	40·0	36·8	33·1	30·4	29·0	27·6	26·3	24·4
100	57·1	48·6	42·9	39·5	35·7	32·9	31·4	30·2	28·6	26·5
120	62·1	53·7	47·9	44·4	40·5	37·5	35·9	34·5	32·8	30·5

Note.—The above table is based on layout having blocks 600 feet long.

TABLE C.

Showing Length of Road in Feet Required for Erven of Various Sizes.

Frontage of Erven in Ft.	Depth of Erven in Feet									
	50	75	100	120	150	180	200	220	250	300
50	31·2	33·3	35·4	37·1	39·6	42·1	43·8	45·4	47·9	52·1
60	37·5	40·0	42·5	44·5	47·5	50·5	52·5	54·5	57·5	62·5
75	46·9	50·0	53·1	55·6	59·4	63·1	65·6	68·1	71·9	78·1
100	62·5	66·6	70·8	74·2	79·2	84·2	87·5	90·8	95·8	104·2
120	75·0	80·0	85·0	89·0	95·0	101·0	105·0	109·0	115·0	125·0
150	93·8	100·0	106·3	111·3	118·8	126·3	131·3	136·3	143·8	156·3
200	125·0	133·3	141·7	148·3	158·3	168·3	175·0	181·7	191·7	208·3
300	187·5	200·0	212·5	222·5	237·5	252·5	262·5	272·5	287·5	312·5

Note.—The above table is based on a layout having 600 feet length blocks and an average width of streets of 50 feet.

Chapter II

THE LAYOUT GENERALLY AND FORMS OF LAYOUT

1. Layout Generally
2. Gridiron Pattern
3. Hexagonal Forms
4. Geometrical Types
5. Radiating Patterns
6. Contour Layouts
7. Recommended System

1. LAYOUT GENERALLY

There are many considerations to be borne in mind when laying out a township and the planner must achieve a balanced result placing the correct importance on each of these various factors. It is fatal for him to allow any obsession to run away with him and in this way achieve perfection in one direction only.

The more important considerations are traffic, street widths, drainage, road grades, aspect, direction of streets, arrangement of open spaces, location of local centres, various uses, sizes of erven, parking, survey difficulties and grouping of buildings.

A design will be much influenced by use, the average size of erven and the length of blocks.

Greed should not be allowed to spoil a township layout by attempting to squeeze as many erven as possible out of a given area. At the same time thought should be given to the elimination or rather non-creation of waste spaces and as many erven, commensurate with as good a design as possible, should be obtained.

There are those who think that the grouping of buildings is the prime purpose of townships layout and they overlook the importance of the proper planning of means of access, forgetting that no building site has any value unless it has means of access.

The purpose of township design is fundamentally to provide sites for buildings and good access to and from these sites. That such provision of sites should be so designed as to permit of the successful grouping of buildings and for buildings to be erected to to the best advantage possible, hardly needs to be stated.

The same importance that attaches to the building sites attaches to the means of access. Under modern conditions the means of access has also become the means for the provision of essential services.

As the means of access is by roads or streets the street pattern becomes all important in the layout of townships.

2. GRIDIRON PATTERN

This form of layout is often termed the checker board or rectangular layout. It is a type that has been used throughout the world from very early times, which date back to the Romans and early Egyptians.

Most of the towns and suburbs in South Africa until recently were laid out in this form. Land surveyors were partial to it owing to the ease of calculating the co-ordinates and the pegging out of the blocks and erven. Very little time was required to design and prepare a plan for this type of layout.

Speculative land developers preferred this system because they thought that it yielded the greatest number of erven from a given area. Unfortunately the shapes of farms and farm sub-divisions are seldom rectangular with the result that a gridiron layout often resulted in much waste by the creation of triangles and other odd shaped, unsaleable pieces of land.

This method has the advantage of creating a large number of rectangular blocks. For townships of small erven the rectangular block has decided advantages over irregular ones. Where erven are large and blocks somewhat regular the above advantage is not of great importance.

The gridiron pattern has many disadvantages and one of the most important of these is the lack of flexibility, which does not allow it to fit a site on steep and broken ground. In such cases it creates roads which are some steep and others undrainable except at great cost. Streets, which run up and down like switchbacks are a result of this form of layout. In most towns streets which are too steep to be constructed may be found in townships of gridiron layout. These disadvantages may be overcome by adapting the gridiron pattern to the contours, but this is of course a departure from the true gridiron form.

Such an adapted gridiron is simple to design and in the hands of a person not very skilled or experienced it will give far better results than attempts to produce something more striking. Many townships designed recently are fantastic and bad. They appear to suffer from a strain to get away from the gridiron at all costs.. Such amateur productions would have been better avoided and the designer would have achieved results less open to criticism by trying to produce the simpler adapted gridiron form.

Direct access to centres of importance are not possible with the gridiron except in two directions. To try and remedy this defect an adaption by super-imposing diagonal streets on the gridiron pattern

has been tried out. This was done in the plan of Washington but it results in a crude and bad plan cutting many building sites into triangles.

Except when used on a small scale the gridiron results in monotony—row upon row of similar streets. In the case of small erven such as in poor areas and locations the resultant effect is a barrack-like one.

Little advantage is taken of any features of interest and all the streets are equally through streets in townships laid out on this system. Because all the streets function as through streets many of them must be made wider than would otherwise be necessary. In addition they must be constructed to carry through traffic. This results in increasing the cost of streets unnecessarily and leaves no streets free from fast traffic with its accompanying danger, noise and dust.

All the above objections to the gridiron form of design become magnified the larger the town becomes.

3. HEXAGONAL FORMS

These being rigid like the gridiron obviously suffer from the same defects except that they may not prove as monotonous.

It has been claimed for these types of layout that they will economise road length. This assumption is based on the fact that the perimeter enclosing a given area is less than in the case of rectangular or triangular blocks. Undoubtedly this is true for an individual block but when blocks are put together in a layout it is quite different.

The hexagonal blocks when put together as in a honeycomb will have less road length than a rectangular layout, using square or almost square blocks. If, however, long blocks are used, the length of cross-streets is reduced and the gridiron is far more economical of road length.

Put together in this way the hexagonal pattern gives zig-zagging roads and is therefore entirely unsuitable.

If put together as shown in Figure 1 direct access is given in three directions and in this the hexagonal form is superior to the gridiron. It also gives a superior layout to the gridiron plus diagonals. A large road area results with this form of hexagonal pattern however and numerous small triangular blocks are created.

4. GEOMETRICAL TYPES

As land surveyors of the past felt for the gridiron so do many architects of the present become obsessed with geometrical patterns. Such patterns may be made attractive on paper or produced in models but often create many difficulties when a township is developed.

On gently sloping sites where the ground is not broken by dongas, valleys, ridges or hills a certain amount of symmetry pro-

duces a pleasing plan and assists in the sensing of direction after a township is developed.

Around central squares, local centres and shopping centres, where the formal pattern is seen on the ground, are the places to make use of geometrical designs.

Access must not be spoilt to obtain symmetry nor must streets with bad grades and bad drainage be designed merely to conform to some geometrical pattern.

It must always be kept in mind that townships are not seen on the ground as viewed on the plan. Only the few who travel by air have the advantage of viewing a township as shown on the plan.

5. RADIATING PATTERNS

This type of layout is often called the spider web form. Just as the spider web provides for the spider the quickest and easiest route to every point of the web from the centre so does this form of layout give the easiest and most direct access from any part of the town to its centre.

The radiating layout consists of a number of main roads radiating from the town centre and linked together by means of ring roads. This framework of main roads is then filled in with minor roads running in the same directions as the main ones.

As a general framework and if adapted to the topography of the site, this system of layout is a good one to use in whole or in part. It should be used as the main framework of a town and with adaptation in suburban areas where local centres are developed.

If used indiscriminately in any township the resultant effect may be bad and cause concentration of traffic and persons at places where they do not wish to be. Orlando, Johannesburg, is an example of the wrong use of a modified spiderweb form of layout.

Used in a rigid form it will have many of the disadvantages of the gridiron or any other set geometrical pattern.

6. CONTOUR LAYOUTS

In contour layouts the predominant set of streets follow the contours of the ground while the cross streets cut across the contours often diagonally in order to ease the grade. Streets must not follow exactly along the contours and be dead flat otherwise drainage troubles will arise.

This type of layout is used on steep and broken ground and in such cases the routes of streets must be selected to pass over necks between kopjies and ridges and in positions where the cross-fall will not be excessive. It is the only practical form to use in steep and broken country.

No centre of a town should be on a site requiring a contour layout and the same may be said of industrial areas.

On rough sites a contour layout will economise road construction and facilitate drainage if done skilfully. It increases the cost of

services such as water and electrical reticulation but the general overall saving against any other form of layout is considerable. It is of course not a system to use on unbroken, slightly sloping land for here it will increase the costs of all services.

In layouts of this form direct access is rarely possible and a certain amount of difficulty arises for strangers to find their way about in suburbs designed on this pattern.

Contour layouts in rough country are largely an engineering problem of road location and only persons with considerable experience of the requirements of road location and construction can possibly be very successful.

7. RECOMMENDED SYSTEM

No particular form of layout should be rigidly adhered to or habitually adopted. The topography of the site and the surroundings must be the dominant factor in determining any layout.

It would be useless planning the nucleus of a new town on a radiating pattern with wide main roads in all directions if the surrounding mountains only allow outlets in two or three directions. This peculiarity of site is found in many places in South Africa.

In the case of seaside towns or towns on large rivers the adapted spiderweb or half spiderweb is a good basis to use for the design. Such a plan lends itself to easy extension in all possible directions if required.

Suburban township layouts usually must fit into a framework of main roads laid down in a town planning scheme. If no such scheme exists the main road system should be made to radiate out from the existing town and the townships planned to fit in to this.

No particular type but rather a combination of the adapted forms of all systems may be used on easy sites. Rough sites, however offer little choice and often only the contour layout is practical.

Before proceeding to lay out a township the points of attraction, which will determine the traffic flow must be carefully considered. Such centres include places of mass employment, main centres of towns, local business areas, schools and railway stations.

When locating and planning the main network, the topography of the area and its surroundings must be carefully considered. The most should be made of vistas of kopjies and distant mountains, clusters of trees, rivers, dams or the sea.

While thinking of these vistas, views and drives, the main points of traffic concentration must be clearly kept in mind and easy access planned to such.

Once the main framework has been laid down, the best procedure is to divide up the spaces between in the most economical way possible.

Around civic centres and open spaces the geometrical form may be followed to advantage if contours permit.

Drainage and road construction should ever be in mind when designing a township. Main roads may be planned in a bolder manner than secondary or local ones and a certain amount of cut and fill to give good grades is in such cases wise.

Intersections and road crossings are important and must be carefully planned avoiding acute angles as well as staggered intersections for roads carrying local traffic only, there should be a distance of at least 200 ft. from centre to centre of the entrance roads so staggered.

In the case of more important roads carrying heavy traffic and where the widths of same are more than 60ft., the staggered distance should be at least 300ft. centre to centre.

The creation of triangular blocks, especially sharp pointed ones, should be avoided as they waste land in subdivision and increase the road length tremendously. Figure 2a shows such triangular blocks and Figure 2b shows how these could have been avoided.

Another feature to avoid is the introduction of a large number of curved streets without any sound reason for doing this. Such planning is commonly seen in recent designs. It is bad planning and results in unnecessary difficulties as well as increased costs of services.

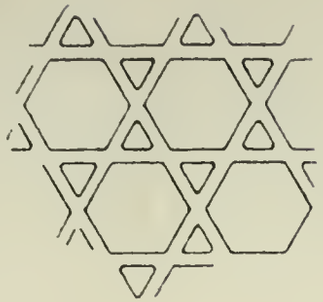


FIG. 1

HEXAGONAL BLOCKS

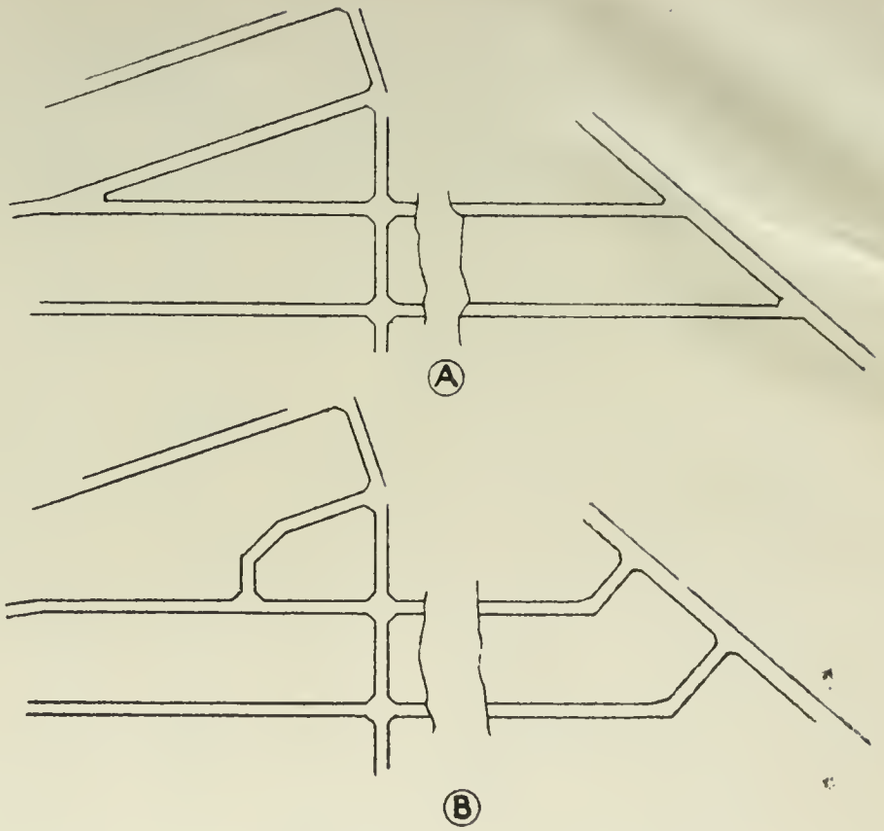


FIG. 2

TRIANGULAR BLOCKS

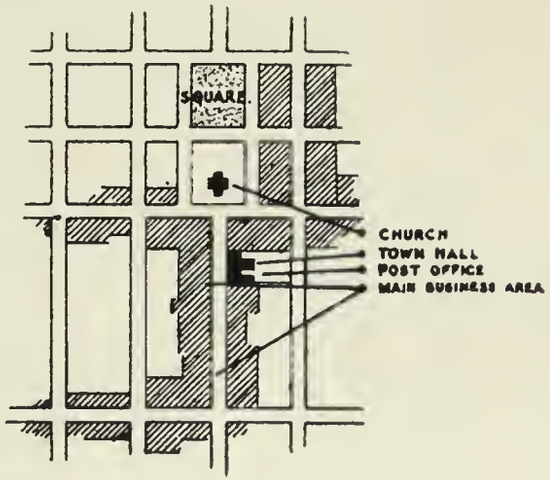


FIG. 3

CHURCH SQUARE,
ROBERTSON

Chapter III

LAYOUTS FOR VARIOUS USES

1. Nucleus of a New Town
2. Residential Townships
3. Industrial Townships
4. Small Holdings
5. Native Locations

1. NUCLEUS OF A NEW TOWN

The layout of what will be the beginnings of a new town is a town planning problem in full, including site planning or township layout work.

In the past the gridiron form was used for all townships, whether these were to be new towns or suburbs of existing ones. One advantage of this method of layout is that it suits both cases equally well, except that wider roads are needed in the former than in the latter.

The gridiron fitted both cases because it was simple in design and not specialised in any way. Although it suited both cases equally it did so not very successfully. In this respect it may be likened to oxwaggon transport of the past. This was used for heavy goods, light goods and passenger purposes. Today this crude all-purpose vehicle has largely been superseded by specialised vehicles for the various needs of transport.

Specialisation, however, demands greater care in design than was needed before. Township design is no exception to this rule. The crude all-purpose layout must give way to specialised townships to suit all particular needs. In spite of this it is astounding to find many purely residential types of townships being designed today for the purpose of forming the nucleus of new towns.

Such townships prove to be ten times worse than the old gridiron. In comparison with adapted gridiron patterns the inferiority of these misfit townships is still more marked.

Any design for a new town must provide a road system that can be extended to become a radiating main framework. From this the super-blocks are built up. An ample area for a business centre, workshops, industries, schools, municipal purposes, government buildings, cemeteries, depositing sites, location sites and suchlike

uses must be provided. The centre must be designed in such a way that the business zone may expand freely in areas first used for other purposes. The town may, to advantage, be planned around a church site and market square or town hall site as was done in many of the best of the older towns in South Africa. Figure 3 shows the Dutch Reformed Church at Robertson which dominates the centre of the town and is a good example of the best of the older towns.

Consideration must be fully given to traffic density and flow, transport routes and parking facilities. Stormwater drainage, sewerage, water supply, electrical reticulation and all other services require thought on a scale vastly different from that of a suburban township where the existing services are merely extended and only small mains are used.

Parks, recreation grounds and other open spaces all assume a different and more complete character than for a suburb.

Not only in area and size will there be a difference in the provision of special sites but the position they take up differs in a new town from a suburban township. For example, a childrens' playground and school may well form the centre of a suburban layout and be its focal point, but this obviously could not be the case in the design of a new town nucleus.

The design of a new town is very much bound up with municipal engineering problems. Unless one has sufficient knowledge to produce a design of high quality it is best to confine all efforts to a simple design such as an adapted gridiron pattern. By doing this some success may be achieved but one shudders to think of the result otherwise. Figure 4 shows a township which has become the nucleus of a new town but was laid out for a suburban township. A glance at this Figure will show how difficult access to the centre is and how a proper town centre cannot develop on this layout. A township planned to be the beginnings of a new town is illustrated in Figure 5. It is planned around the town hall site.

The most outstanding features of this design are the wide main roads of 80 and 100ft. which radiate from the civic centre and main business centre and the provision of by-pass roads around these centres. These main roads provide for direct access to the centre of the town as well as for by-passes to enable through traffic to skirt around the centre.

Another good feature is the arterial road which skirts along the edge of the town and not through it. Unfortunately this runs along the railway line and rather cuts off the town from the railway station. This weakness can, however, be easily overcome by making access to the railway station *via* pedestrian bridges or subways.

A wide 120ft. avenue from the railway station and arterial road to the civic centre has been planned and this can be designed in detail to give easy pedestrian access to the railway station.

Surrounding the business and civic centre is a residential area planned in such a manner that conversion to shopping or business purposes will be easy if the need arises. The business area as shown

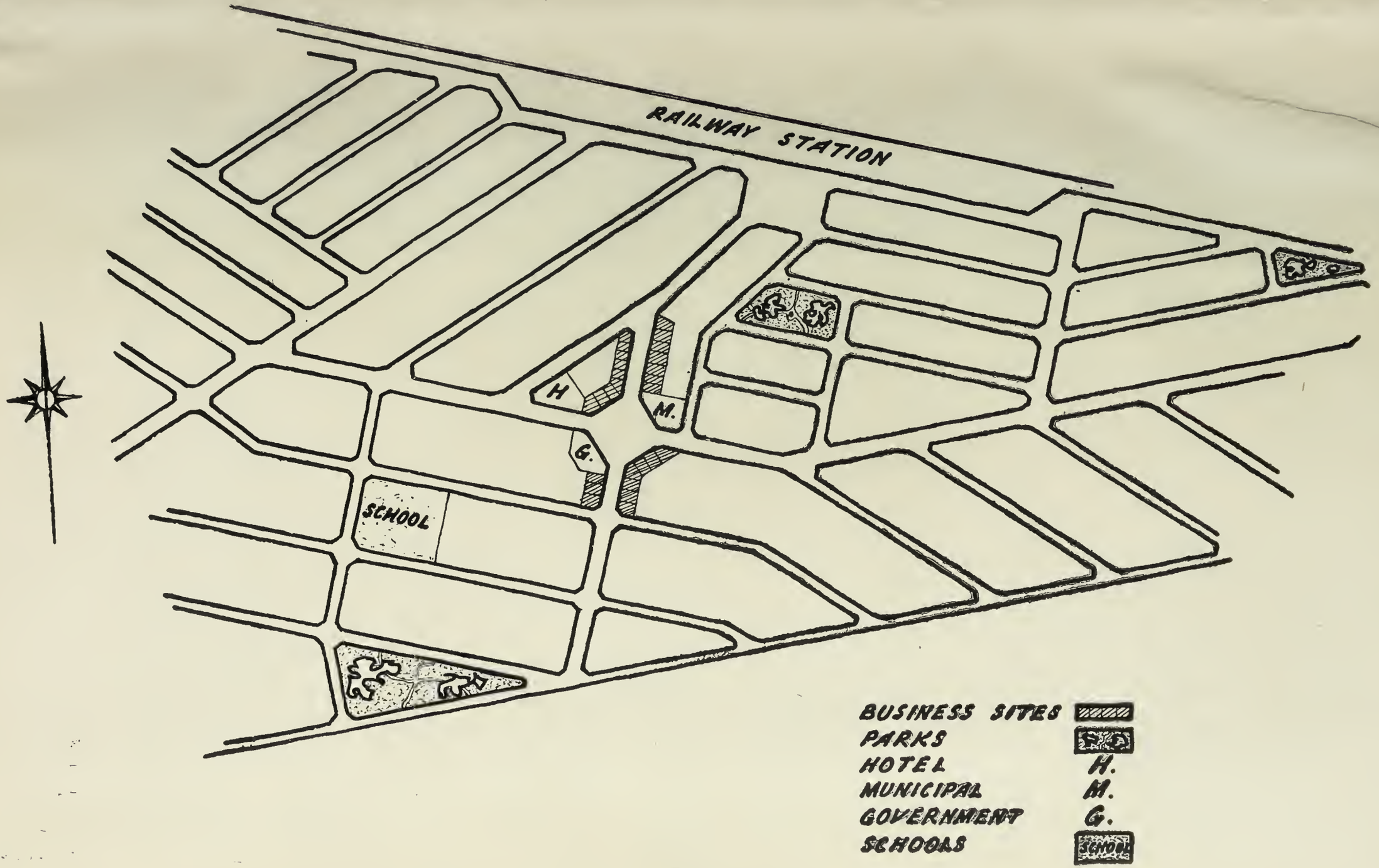


Fig. 4

TYPICAL EXAMPLE OF BAD SUBURBAN TOWNSHIP
DESIGN PROPOSED FOR BEGINNING OF A NEW TOWN

is large enough for a population of 30,000 persons. Adjoining the business area is a zone for workshops and small industries.

Provision has been made for a central high school and a central main recreation ground adjoining same. Numerous other small parks and schools have been planned as well as ample open space and park in the town centre.

Attention is also drawn to the manner in which the difficult north-east triangular corner of the site has been planned. Two examples of extensions to existing towns but so designed that they will respectively become the centre of the town are illustrated in Figures 6 and 7.

2. RESIDENTIAL TOWNSHIPS

Residential townships allow for more variety in design than any other type of layout. On rough sites, as already mentioned, only contour layouts will prove satisfactory, but these are so informal that a great variety of design is possible.

The size of erven is a factor which considerably affects any lay-out design. The blocks decided upon should provide for rather deep than wide erven in order to economise road length and services. Proportions of width to depth of erven should vary according to the size of the erf. A good proportion for small erven of 5,000 to 10,000 square feet is 1 : 2 *i.e.* the depth is made twice the length of the frontage, such as 50 × 100ft. For larger erven the proportion of depth may be increased up to 1 : 3.

Considered from the aspect of economising road length and road services the deeper the erf for a given area the better, but there are other factors to consider. After all the prime purpose of an erf is to provide a building site for a certain class of building.

On steep sloping land buildings are designed to be long with proportionately small depth and in order to save foundation are sited with the greatest length along the contours. In such cases the designer of the township is justified in decreasing the proportion of depth to frontage of erven and even square erven may be best in extreme cases.

Length of road is also economised by making the blocks of erven fairly long. Such may be 1,200 to 1,500ft. long when placed internally in townships. Along main roads they may with advantage be increased to 2,000ft. or half-a-mile to minimise intersections with the main road. In cases where the main road is not an arterial road such as a national or provincial road, a pedestrian lane or a park should be introduced to break down the long blocks to about 1,000 to 1,200 feet lengths for the convenience of pedestrians.

Before deciding upon the length of blocks consideration must be given to the future movement of people. Around local neighbourhood or shopping centres and schools or other places of concentration blocks should be shortened to from 500 to 800ft. in length in order to facilitate ease of access.

More use than at present could be made of road bays in which trees may be planted without interfering with overhead electrical and telephone distribution wires. Clusters of trees particularly when mixed with flowering varieties may be very attractive.

When planning a large township the super-block idea with main traffic routes enclosing areas of approximately ½ mile square has much to commend it. An area of this size ensures that no residence will be more than a quarter mile or five minutes walking distance from a main road or bus route.

This system assures suitable and payable bus routes and therefore keeps these vehicles on the wide roads provided instead of forcing them for economic and convenience reasons to adopt routes along narrow roads.

It also means that local traffic soon sorts itself into the streams on the main roads and thus minimises traffic movement within the super-block. This principle was introduced by the author into the main road plan of Vanderbyl Park.

The street pattern of a super-block should be so designed as to encourage the canalisation of traffic into main routes and to discourage through traffic from passing along residential streets.

One must not be caught by the catch phrases of persons who have adopted the methods of patent medicine vendors to advertise badly thoughtout notions and ideas. Much of this may be found among designers of townships of the so-called green belt towns in which weird things are done to eliminate traffic.

These designers often display ignorance of traffic movement and usually increase it in their attempts to reduce same.

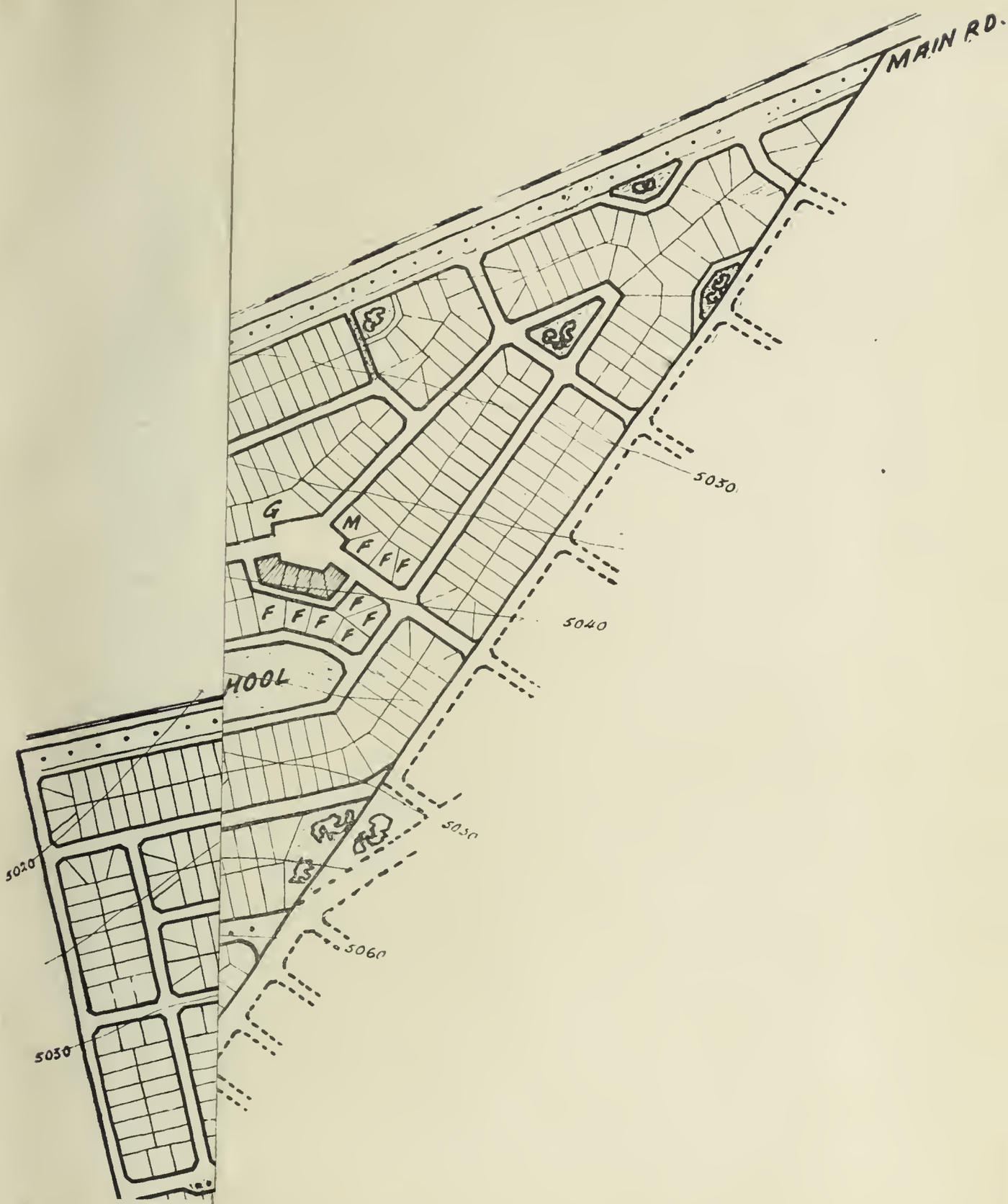
In outer residential suburbs there is little traffic particularly if the super-block form of design is adopted. It is therefore unnecessary to strain a layout design to eliminate possible traffic dangers that will never or exceedingly seldom occur.

The long culs-de-sac used in many designs increase traffic mileage considerably and each creates a danger point to children at the traffic turning end of the cul-de-sac. Uneconomical and inconvenient townships are produced by such methods which destroy direct vehicular access.

By placing public open spaces, parks and schools in blocks at the back of erven, road length and services are economised. A back open space however adds nothing to the value of surrounding erven in the way that fronting on to an open space does. This loss in value probably more than offsets the saving in road length and services.

Apart from this, public open space at backs of erven, unless such spaces are very large, become rubbish heaps, latrines for native servants at night and places where burglars may hide from the police patrols. They are in fact totally unsuited to our conditions and are rightly frowned upon by the Transvaal Townships Board.

Every residential township should provide open spaces and local parks for the needs of the population it caters for. This should


MAIN RD.
5030
5040
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HOOL

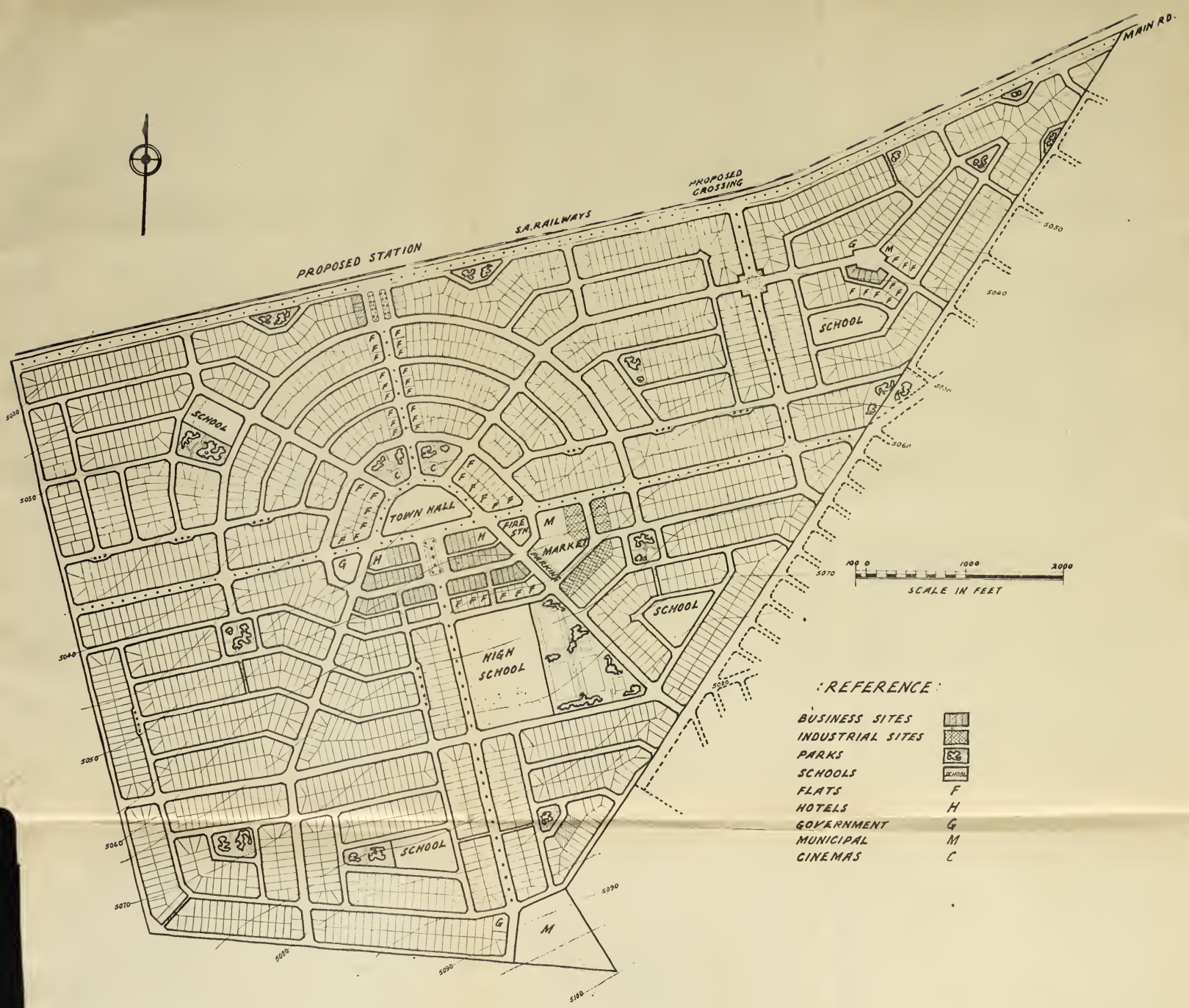


Fig. 5
LAYOUT OF BLYBANK

Designed by
Bowling & Floyd

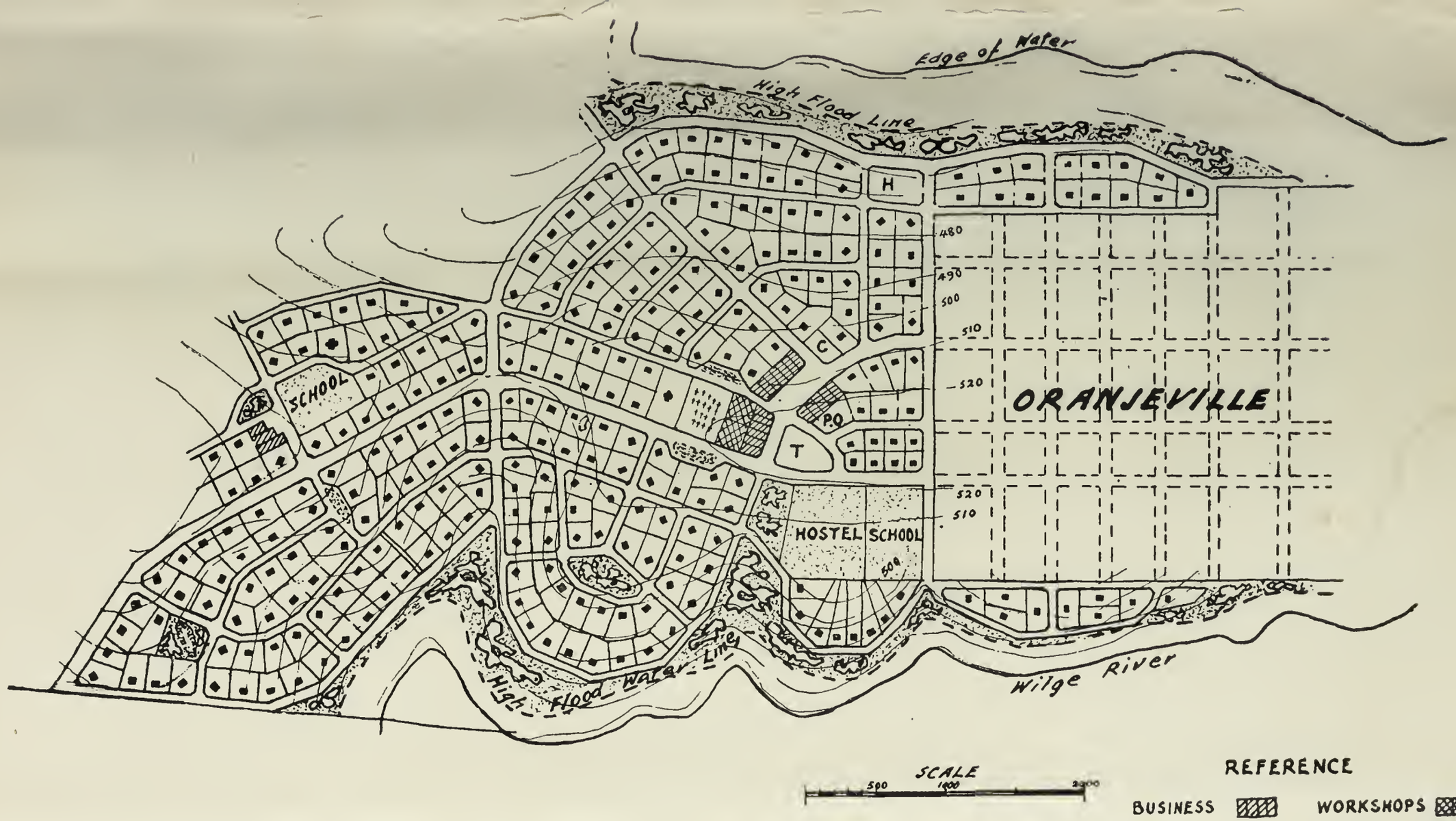


Fig. 6
EXTENSION TO ORANJVILLE

Designed by
T. B. Floyd

NOT

LENGT

OPPER

D

TOTAL

SEMID

MINIM

STEILS

LAND

LOKAAL PLAN
SKAAL: 1: 250,000
DORPSGRONDE
Nasionale Pad
Na Rhodesia
Na Johannesburg
Na Rooiwal Plantasie
Na Sibasa
Sibasaweg
Jacaranda
Skool 1703
Koos Grobler Park 1704
Verbena 50' Street
Olifant Straat
Eland
Buffel
Kafferboom Straat
Bokemia
Malfa
Baobab
Plein vir Parkering en Byeenkomste
Munisipale 1953 Doeleindes
Piet Joubert Park 1840
Petunia
Dahlia
Logu
Kanzeel
SKOOL In Reserwe Gehou vir Opvoedkundige Doeleindes 1956
Alwyn
Protea
Naboom Straat
Dassie Straat
Acacia
Kiaat 60' Street
Tamboti
Van Riebeeck Park 2088
Skool 2089
Mimosa
Mopani
Kruger Park 2129
Granaat Str
Impala
Azalea
Kwagga Str
Rooibok
REFERENCE:
PARKS
SCHOOLS SKOOL
BUSINESS
TOWN HALL T.
MUNICIPAL M.
GOVERNMENT GOV.
HOTELS H.
CINEMAS C.
GARAGES GAR.
POST OFFICE P.O.
FLATS F.
0 100 500 1000 1500
SKAAL
VOORGESTELDE ONTWERP VAN
PROPOSED LAYOUT OF
LOUIS TRICHARDT UITB. EXT. 2
GELEË OP DIE PLAAS
SITUATE ON THE FARM
BERGVLIET No. 52
DIST. ZOUTPANSBERG
SKAAL: SCALE: 1:2,500
NOTA:-
Lengte van Paaie — 12 Myl
Oppervlakte van Paaie — Morge 46 = 24% (Ongeveer)
Do. do Parke, Oop Grond & Plein — 12 = 6% Do.
Totale Oppervlakte van Voorstad — 192
Gemiddelde Grootte van Standplase — 100'x200' en 80'x120
Minimum do do do — 60'x120' (Besigheid) en 80'x120' (Woongebied)
Steilste Helling langs Gedeeltes Baobab & Malfastrate – 1:12
LANDMETER/SURVEYOR
1946
Designed by Bowling & Floyd

Fig. 7

at least amount to 3 acres per 1,000 persons or 200 erven. Such open space should at least include sufficient flat land to provide for tennis courts, jukskei and other local recreation needs.

Such township if in private ownership should provide for its own local needs and cannot be expected to provide the parks for larger areas. The total park and public open space in a town should be at least 10 acres per 1,000 persons, but this area is largely made up of the large parks and picnic grounds. Such areas are from 25 acres upwards and can therefore not possibly be taken out of the average township.

Streams and water courses if not in parks should be planned in open space strips, which may be developed as pleasant stream walks but at the same time are predominantly for the proper control of stormwater drainage. Anti-soil erosion measures may also more easily be carried out if streams are in open spaces. Such park strips provide good routes for main sewers.

Rocky ridges unsuitable or expensive to build upon ought to be preserved as wild open spaces where children may clamber about and grown-ups take the dog for a run. By doing this much expensive road making will be avoided.

Examples of Residential Townships are shown in Figures 8 to 14.

A small site of triangular shape—always a difficult one to plan—which was designed for an area at Springs is shown in Figure 8.

Van Riebeeck Township, Uitenhage is illustrated in Figure 9. This is a small township on the side of a steep hill. The road system has been designed in such a manner that the majority of the streets have easy grades. Roads going uphill mostly do so diagonally across the contours.

In Figure 10 is shown Linton Grange at Port Elizabeth. It is an example of a large township laid out on the super-block principle. The main roads enclosing the super-blocks follow the topography of the site. Each super-block is planned with its own local centre and school. Liberal park and open space area has been provided. The sizes of erven vary from 10,000 square feet to one acre and the most common size is 80ft. $\times$ 140ft.

A proposed township laid out on the farm Kwaggafontein district Bloemfontein is shown in Figure 11. This township is also laid out on the super-block principle. Full advantage is taken of the twin kopjies to provide commanding sites for churches. The churches on these sites will dominate the whole layout.

Streets are planned to lead to these church sites and they will terminate in vistas of the churches.

Connecting the church sites to the main approach road are two parks. This road will pass over a saddle between the churches to lead on to the main local business centre, which has been planned on a fairly level site.

Advantage is taken of the lowlying land to provide a large recreation ground. Ample parks and open spaces are provided and these are well distributed over the township in such a manner that every super-block is provided with a park.

A local business centre has been planned in each of the super-block units.

A township on a river front is shown in Figure 12. This is at Redhouse near Port Elizabeth. The main feature of this township is the use of bays to give river frontage to as many erven as possible. Back access has been planned to these river front erven in order to preserve the river front for pedestrians and keep it free from vehicular traffic. This enables boats to be drawn up out of the water for repairs, examination and storage.

Figure 14 illustrates a group of townships laid out on the super-block principle for the extension of Upington. Local business centres are provided and each super-block unit is provided with park or public open space.

The water courses are protected by being in park strips.

The main road system is planned to feed directly towards the main centre of the town and to fit with the topography of the site. These main roads have widths of 80, 100 and 120ft. The internal roads are planned as usual with this form of layout and are predominantly 50ft. wide.

3. INDUSTRIAL TOWNSHIPS

Undulating, steep or rough sites are unsuitable for industrial townships. These often require a large tract of flat land. For industries which do not require railway sidings the choice of site is wider in regard to topography.

Railway facilities are essential for most large industries.

Railway tracks are limited to certain grades and curves and this makes the railway system not very flexible. In fact it is the least flexible of all services in a township. For this reason industrial townships must be practically designed on the framework of the railway siding system. The railway siding system is the most expensive of all the services that are provided and must therefore, if economy is to be pursued, be the more carefully considered.

Grades of feeder lines should not exceed the ruling grade on the section and rarely more than 1 in 70. Where trucks stand, such as on loops and sidings, the grade must not exceed 1 in 400. The nearer the grade of the feeder lines to 1 in 400 the less will be the trouble experienced with cut or fill in the case of siding spurs. Curves are limited to 500ft. radius but may, in special cases and with check rails, be 450ft. radius. Clearances should be at least 12ft. from the centre of the track to any boundary fence, wall or building and 13ft. from centre to centre of track.

On the inside of curves, buildings and obstructions must be kept back to give a 600ft. sight-line.

SUGGESTED LAYOUT OF SMALL TRIANGULAR AREA AT SPRINGS

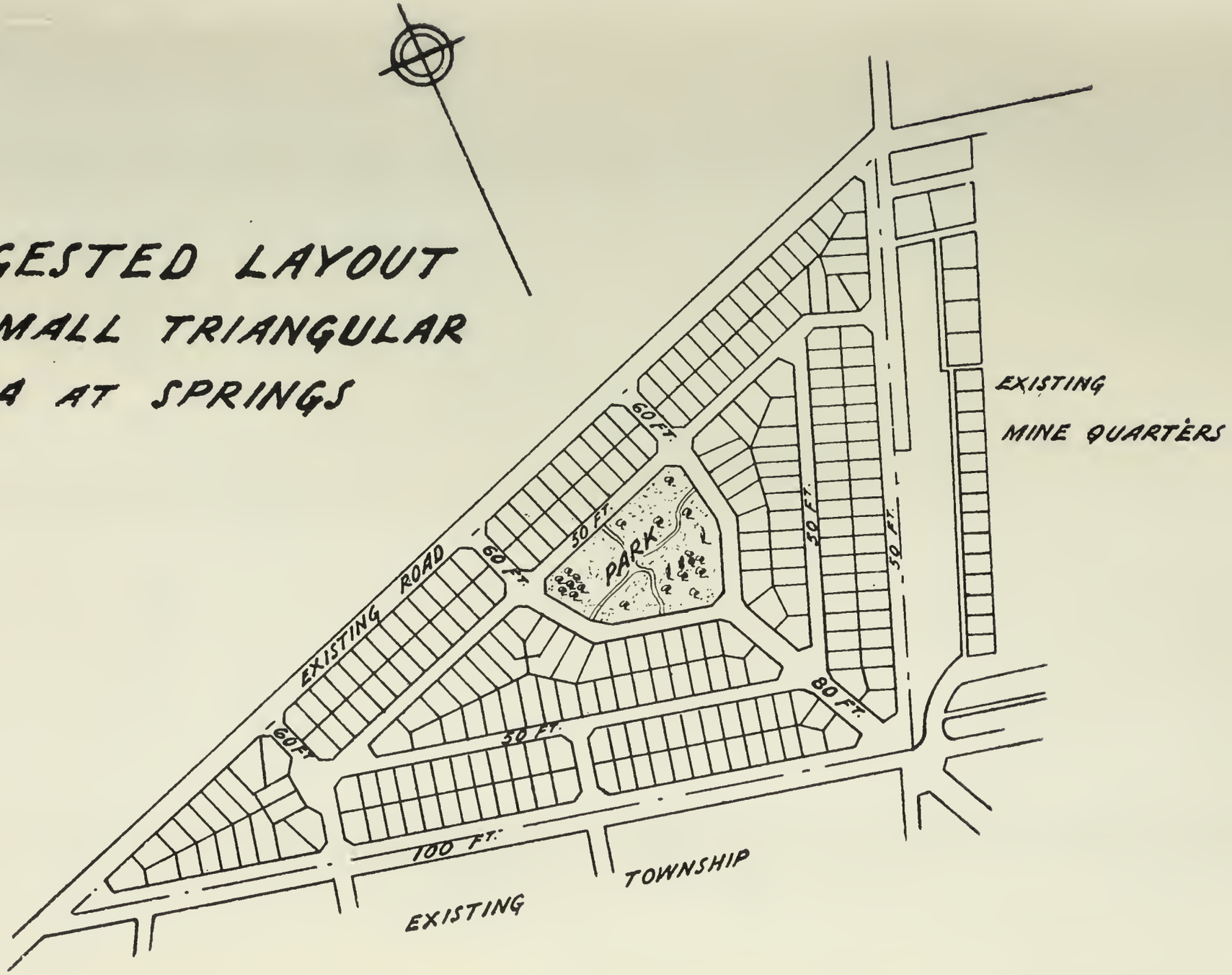
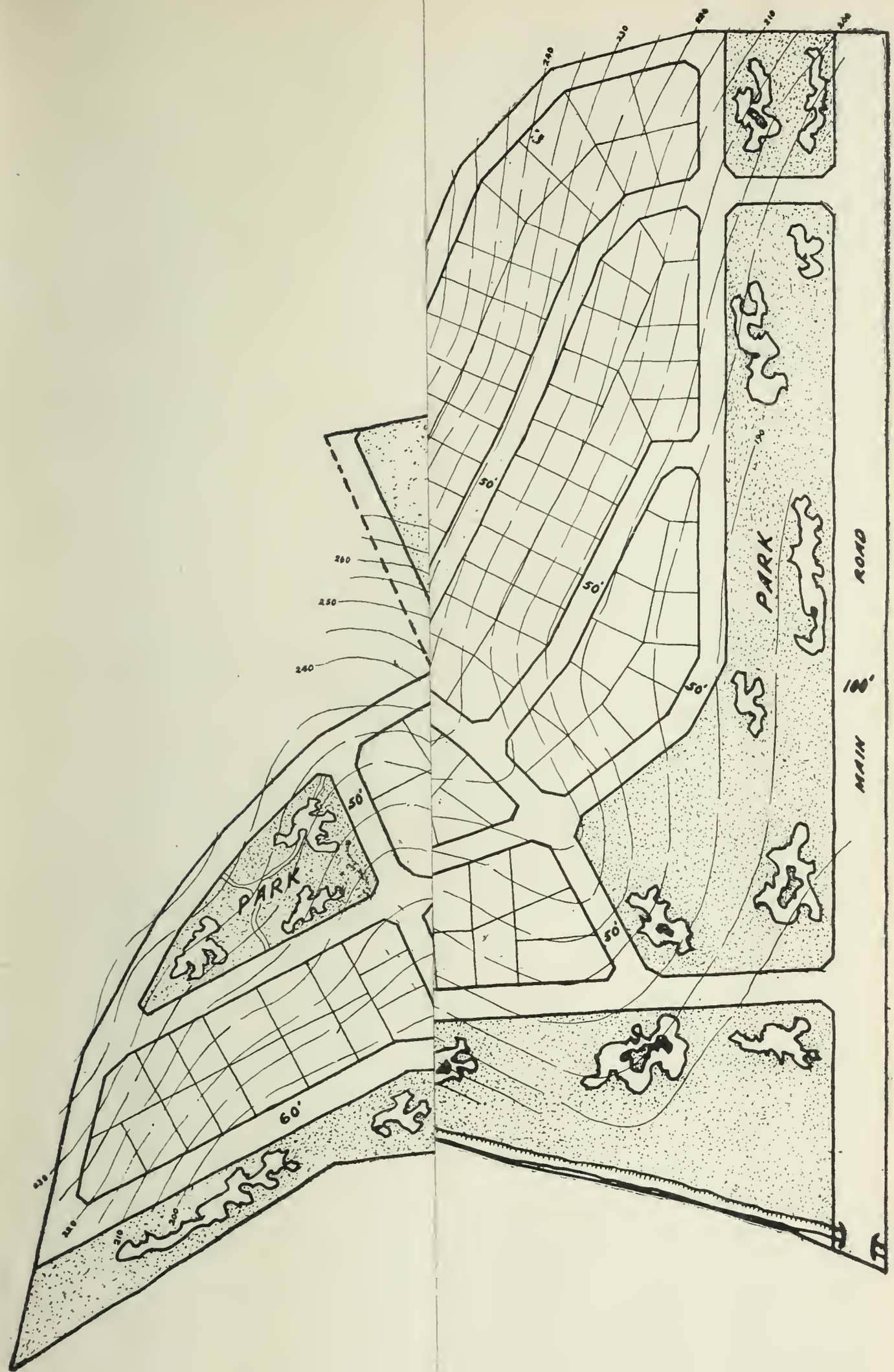


Fig. 8

Designed by
T. B. Floyd



Designed by
T. B. Floyd

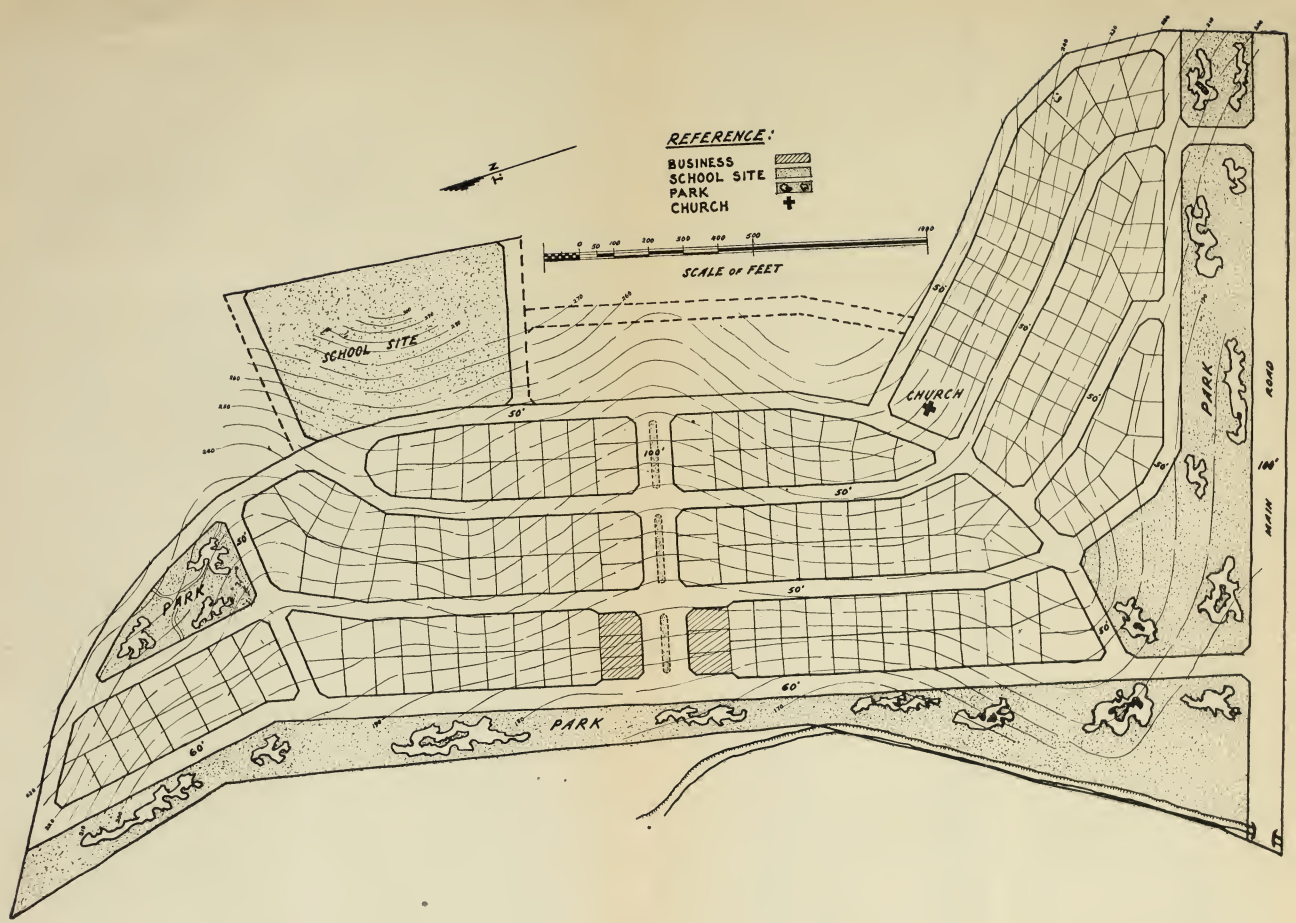
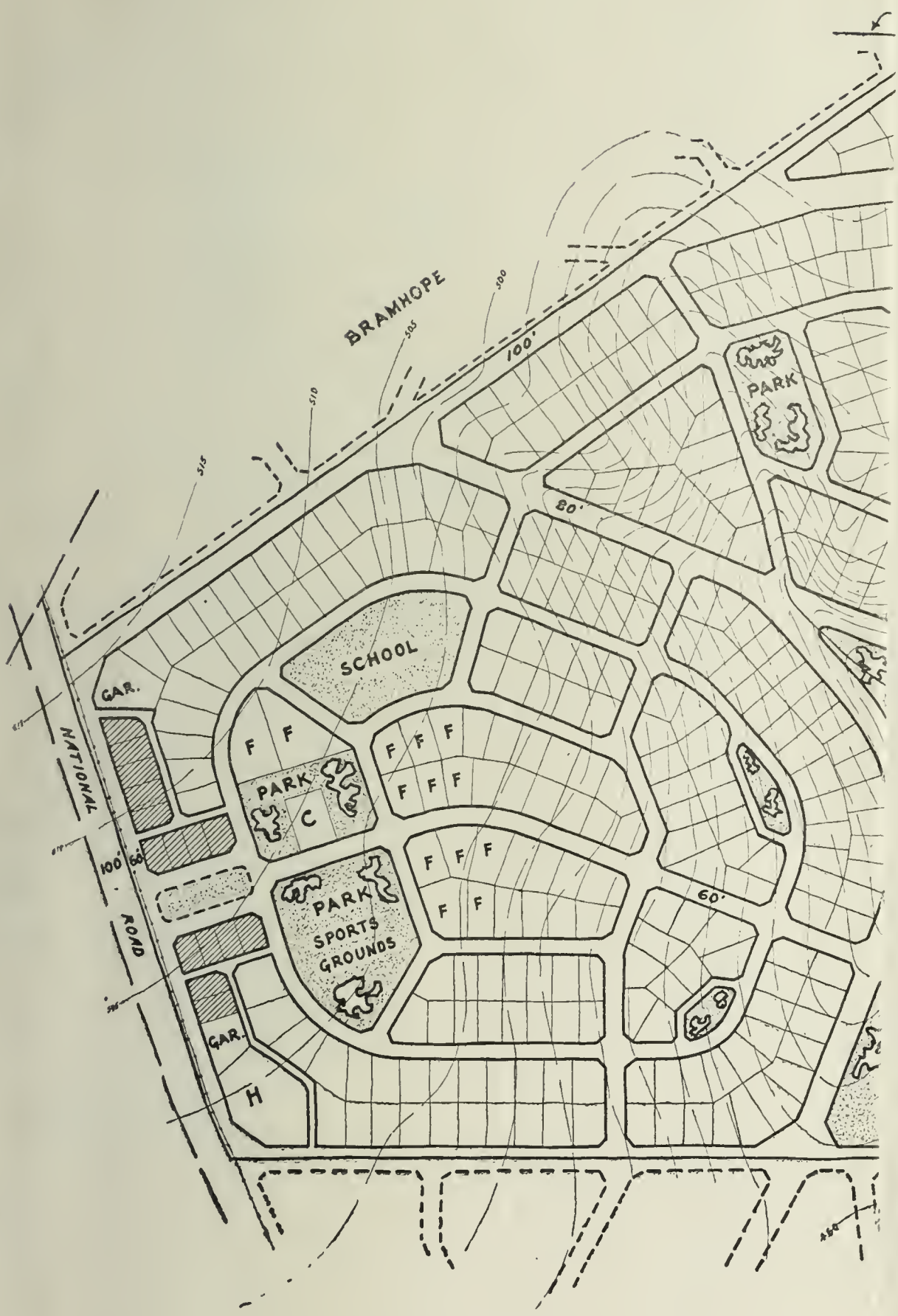


Fig. 9
VAN RIEBEECK TOWNSHIP, UITENHAGE

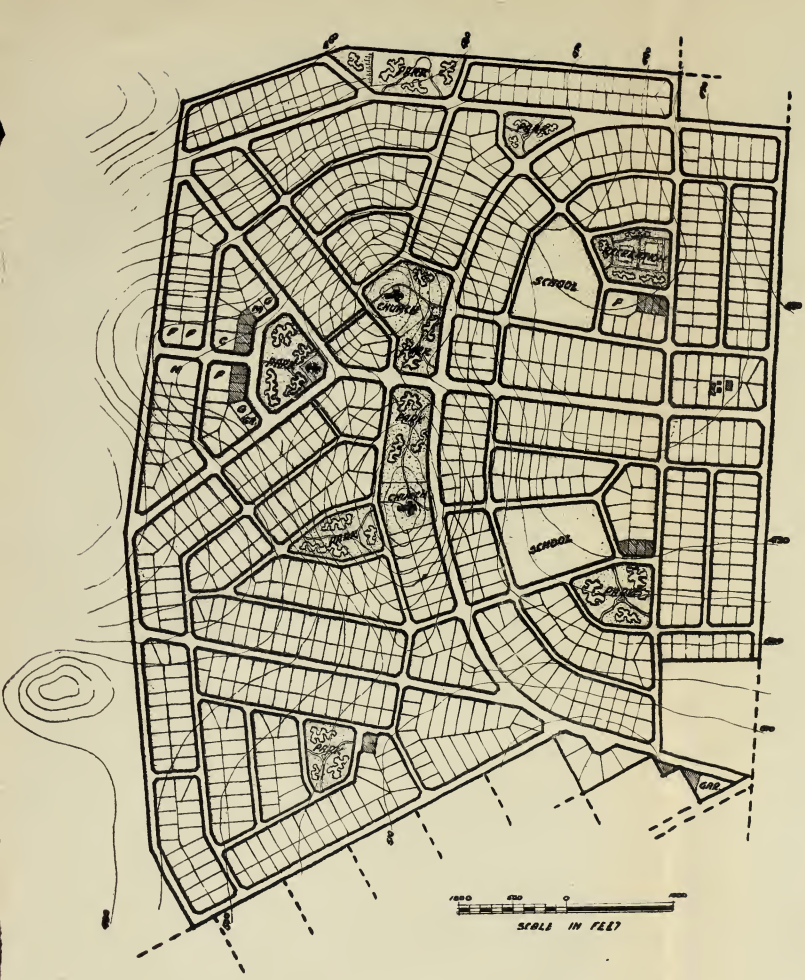
Designed by
T. B. Floyd


BRAMHOPE
100'
80'
60'
PARK
SCHOOL
GAR.
F F
F F F
F F F
PARK
C
PARK
SPORTS
GROUNDS
F F F
F F
GAR.
H
NATIONAL
100'
50'
ROAD
500
505
510
515

TOW

TOWNSHIP OF LINTON GRANGE, PORT ELIZABETH

Designed by
Bowling & Floyd



REFERENCE

BUSINESS SITES	
PARKS	
SCHOOLS	
FLATS	F
HOTELS	H
GOVERNMENT	G
MUNICIPAL	M
CINEMAS	C
GARAGES	GA

Fig. 11
TOWNSHIP ON KWAGGAFONTEIN- BLOEMFONTEIN

Designed by
Bowling & Floyd

Designed by
Bowling & Floyd

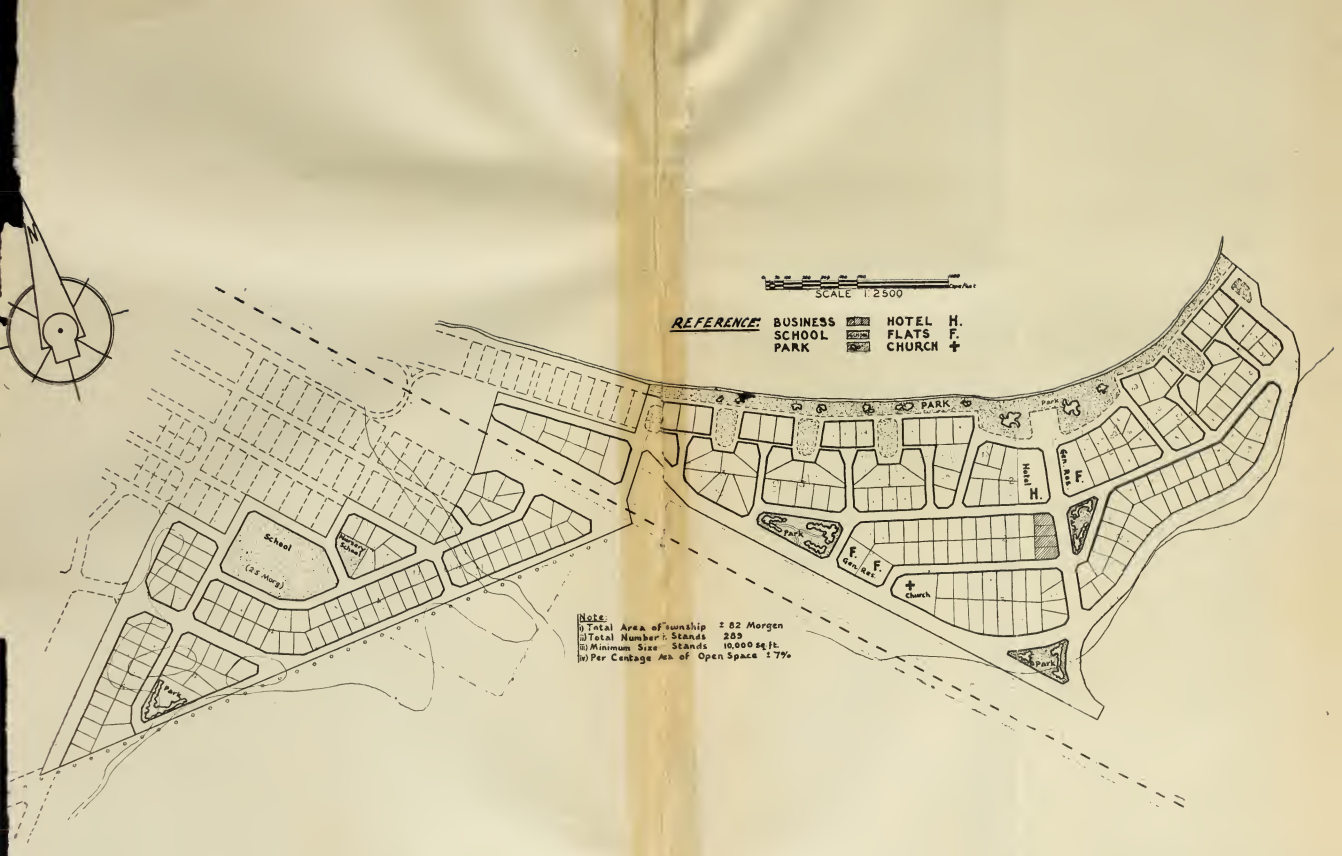


Fig. 1
PROPOSED LAYOUT OF REE-HOUSE EXTENSION No.1

Designed by
Bowling & Floyd

TOWNSHIP OF

PROPOSED LAYOUT OF THE RESIDENTIAL TOWNSHIP OF

REDHOUSE EXT Nº 5.

SITUATE ON ZWARTKOPS RIVER WAGON DRIFT
PORTION OF LOT B & PORTION OF FISH
WATER FLATS · DIST OF UITENHAGE C.P.

SCALE 1 2500

Salt Pan

Salt Pan

Pollokshaws

ZWARTKOPS RIVER

SCHOOL

SCHOOL

SCHOOL

N.S.

REFERENCE:

- Business
- SCHOOL Schools
- Parks
- F Flats
- H Hotels
- M Municipal
- G Government
- † Churches
- N.S Nursery Schools

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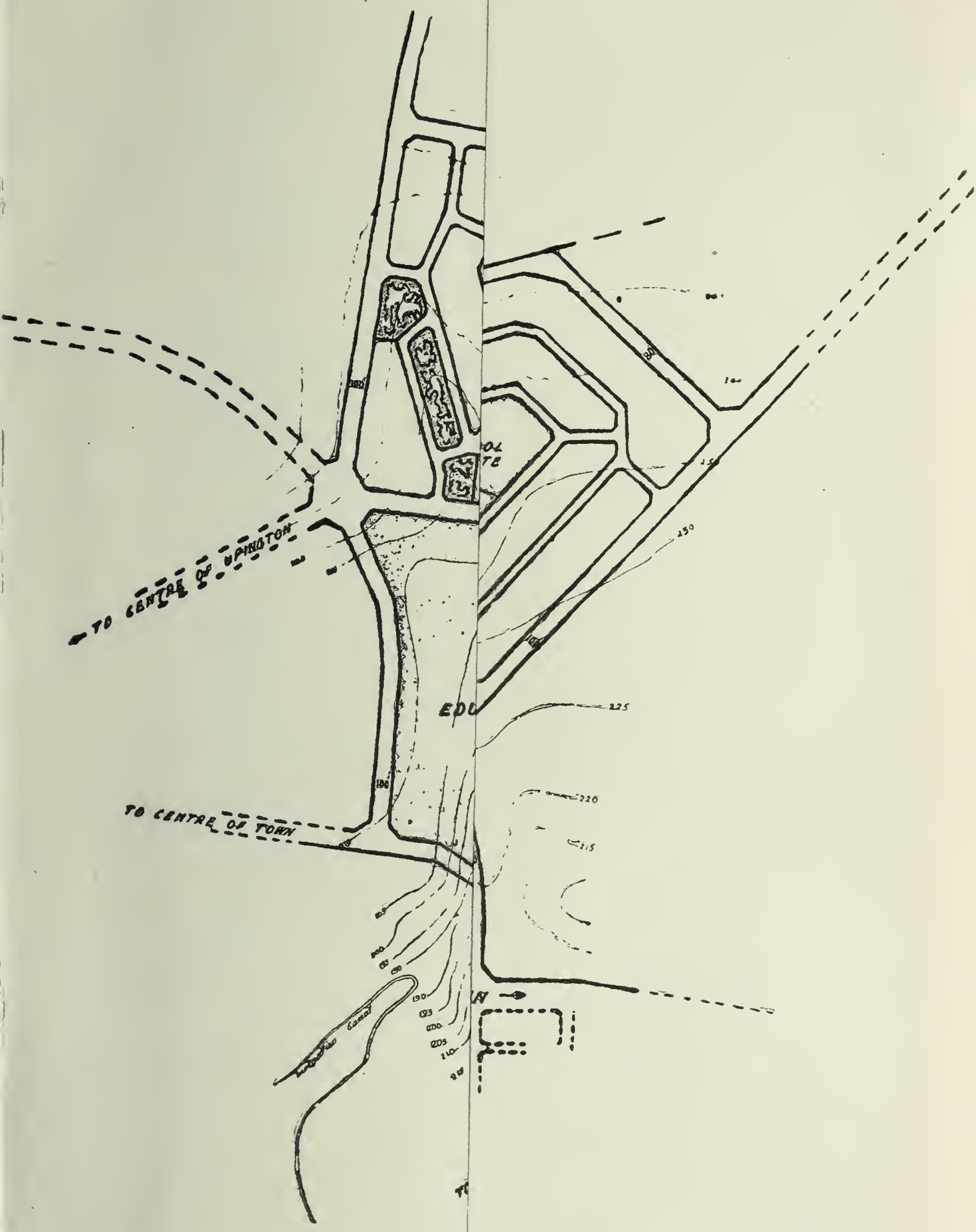
TOWN PLANNING CONSULTANTS
17-19 CORPORATION BUILDINGS
RISSIK STREET · JOHANNESBURG



Designed by
Bowling & Floyd
in collaboration
with Dr. E. J. Hawlin

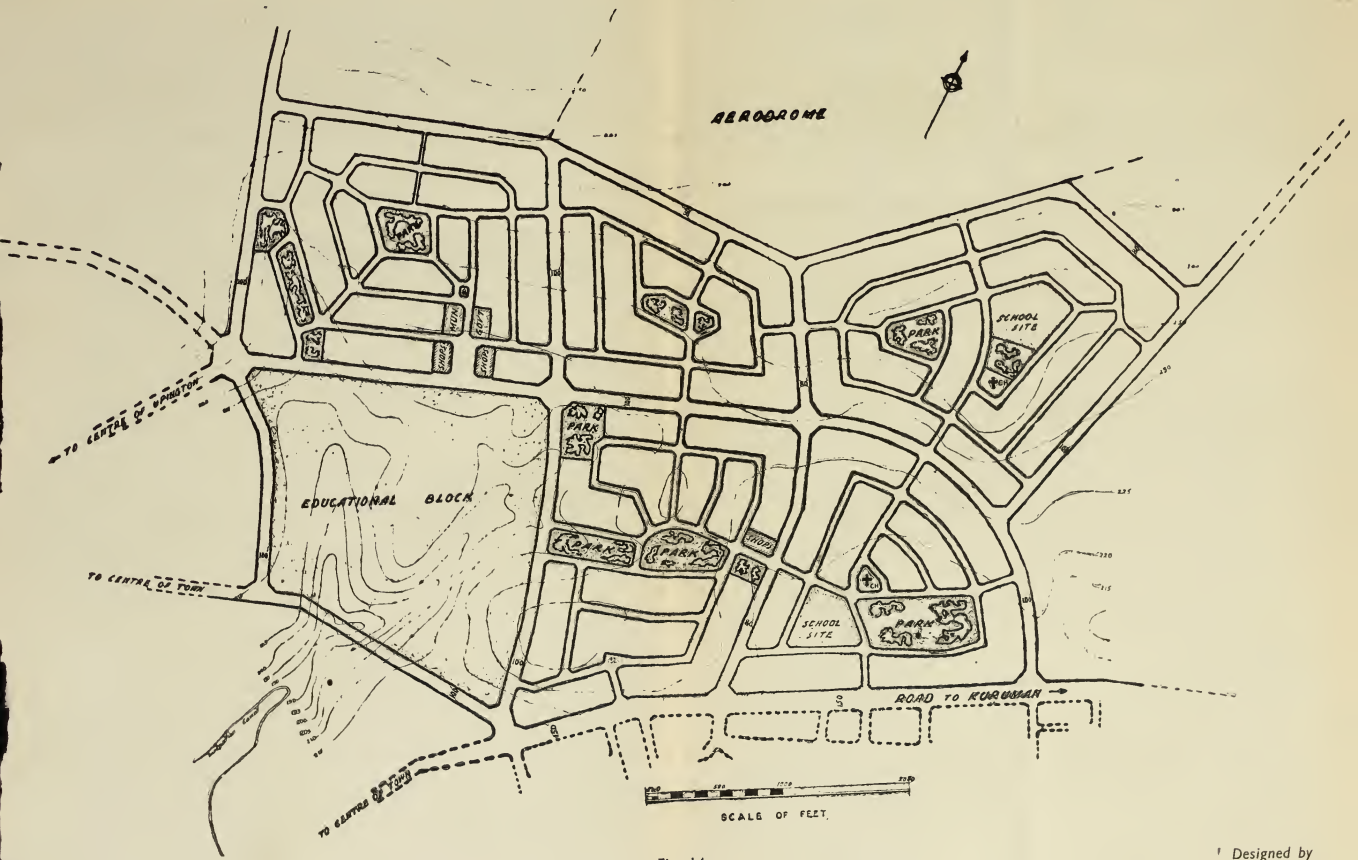


Fig. 14
EXTENSIONS TO UPINGTON

[1] Designed by Bowling & Floyd in collaboration with Dr. E. J. Hawlin

Erven of industrial townships where railway siding facilities are provided usually range from 1 to 6 acres and this will determine the size of the blocks. It is usual to make special arrangements for large industries requiring 20 to 100 acres.

The blocks in an industrial township may be long for there is little intercommunication between sites. They should, however, not much exceed half-a-mile in length or inconvenience is caused to circulating traffic.

Railway crossings ought to be kept to a minimum and as far as possible should take place where the railway traffic is least. This may be achieved by planning the main roads of the township around same in such a way as not to cross any railway lines except the one main feeder.

In industrial areas traffic is composed of heavy vehicles as well as all other varieties. Many of the heavy vehicles have trailers attached and in some cases even trains of trailers. Such traffic cannot manoeuvre about easily or turn freely and for this reason sharp bends should be avoided and so should road islands. Culs-de-sac are not suitable and should only be used under very special circumstances and to give access to one or two sites only. Long culs-de-sac are totally undesirable in industrial townships and, if used, the turning space should be around a park in order to make it easy.

There are three methods of taking off the siding spurs to erven and these are illustrated in Figure 15, A, B and C. The methods in Figure 15, A and B are more commonly used and are suited to sites when the feeder line is running with or slightly diagonally to the contours. Figure 15 B avoids cut and fill most on steeply sloping sites but Figure 15 A provides far more railway track for the accommodation of standing trucks. To get 100ft. length of standing truck space on the erf in the case of Figure 15 B requires a total length of 250ft. erf frontage, whereas in Figure 15 A a 225ft. frontage will allow 200ft. of standing truck space.

The method shown in Figure 15 C is suitable for large erven and not small ones. It is usable to best advantage on very flat sites of natural slope of not more than 1 in 80 and where the contours run as shown in Figure 15 C.

It results in parallelogram-shaped erven which waste land somewhat as compared with rectangular ones but this disadvantage becomes less the larger the erf is. A layout using this method may experience difficulties in providing for necessary turnouts and crossing places unless the site is very flat in places to allow these.

Often all three methods may, with advantage, be used in a single township. Individual erven may be served in a multitude of different ways according to circumstances.

Provision should be made in industrial townships for parks and public open spaces where workers may rest during lunch hours. Adjoining such open spaces, which should be provided for Non-Europeans as well as Europeans, business erven for tearooms and

Native eating houses should be planned. A central shopping area is also a good feature to sometimes introduce into these townships.

Ample space ought to be provided for Native recreation. Industrial zones offer the opportunity to plan Native recreation grounds well away from any European residential areas.

In Figure 16 a large industrial township designed for a site at Lenz Station near Johannesburg is illustrated. A feature of this township is the focal centre at the railway station. This has been planned as a business centre with provision for shops, offices and an hotel. Tearoom and fruit shop sites as well as those for Native eating houses and trade are planned at various parts of the township and adjacent to parks.

A large township planned for a site at Zwartkops near Port Elizabeth is illustrated in Figure 17.

This design provides ample shopping and park facilities. A bad feature is the long culs-de-sac insisted upon by the South African Railways to avoid level crossings.

The ends of these culs-de-sac have been joined by strips of public open space. These allow the circulation of pedestrian traffic and will also permit the connection of the culs-de-sac by roads if found necessary at a later date.

As the blocks are long they have been broken by means of park strips which facilitate the movement of pedestrians and cyclists.

The turning space at the ends of the culs-de-sac are around parks and will thus be easy for trailers and large vehicles.

Figure 18 illustrates a township with the railway feeders laid out on the herringbone pattern. This township is at Alberton. The railway system is satisfactory but it has resulted in a rather awkward road system and a number of level crossings over the main feeder line. It will be noticed how well this system of railway layout fits the topography of the site.

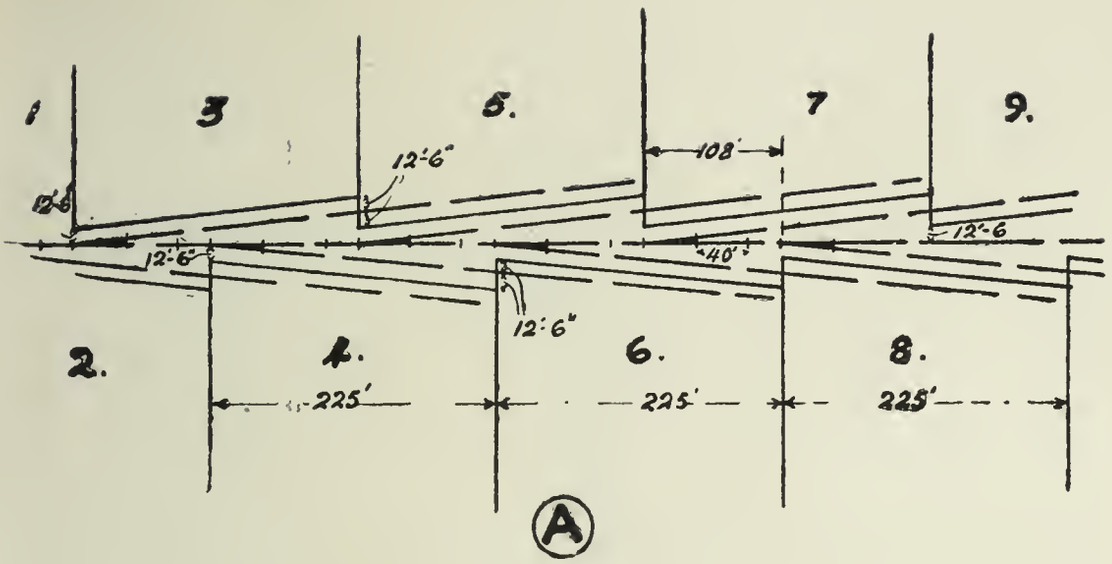
4. AGRICULTURAL SMALL HOLDINGS

Soil and water supply are the two most important requirements of small holdings. If there is any doubt about such supply it is far better to first subdivide land into larger plots rather than small ones.

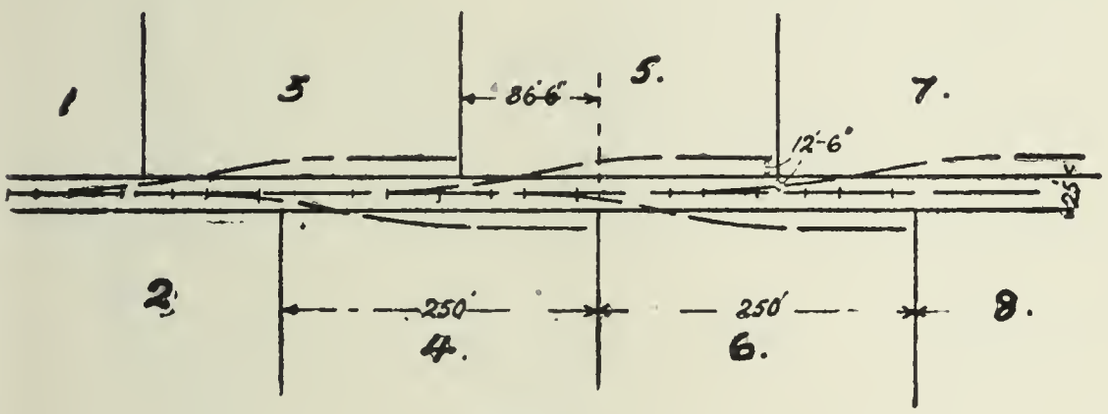
A demand exists at present for holdings to be used for rural residential purposes and provision should be made to meet this demand by means of rural townships. These may be allowed to use ground unsuitable for holdings and plots may be permitted from a half-morgen* up to ten morgen. Such townships must of course be designed on township and not holding lines if a good result is to be obtained.

Water supply for holdings may be either surface or underground. The former will be from a spring, river or dam and therefore measurable beforehand. This enables the amount per holding or morgen to

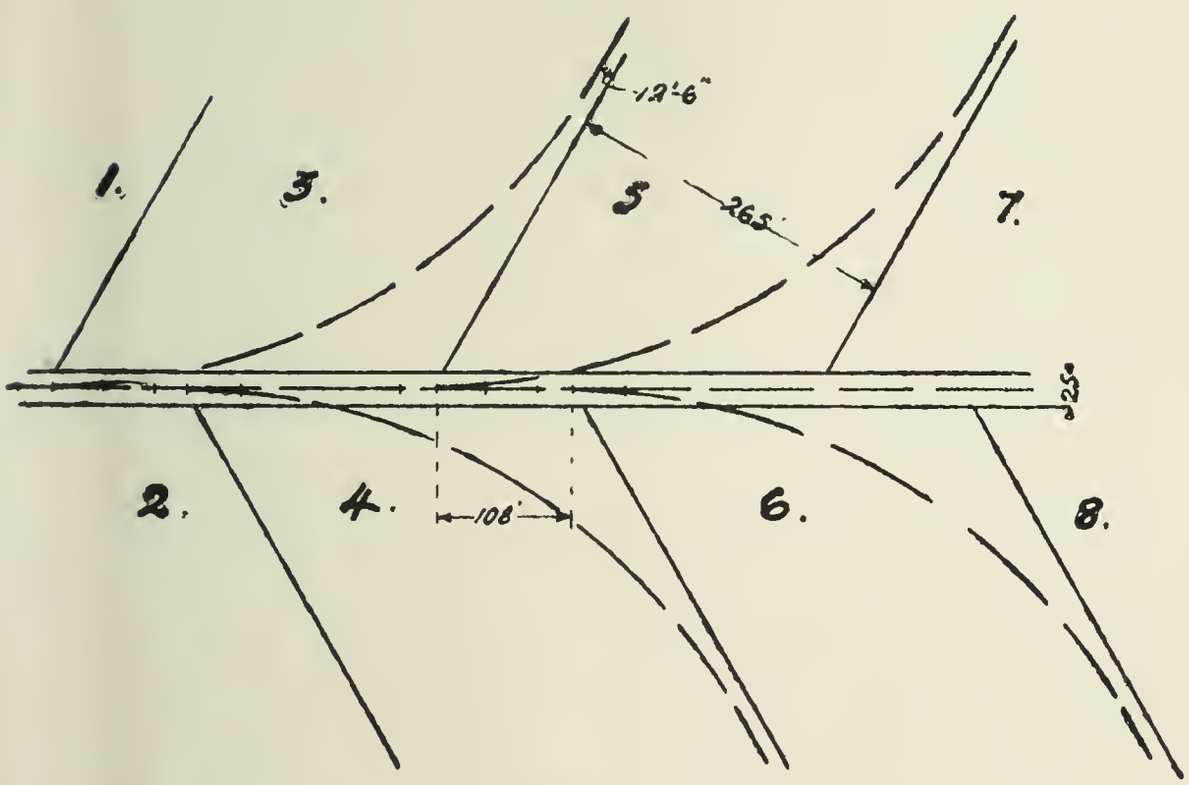
* 1 Morgen = 2⅛ Acres.



A



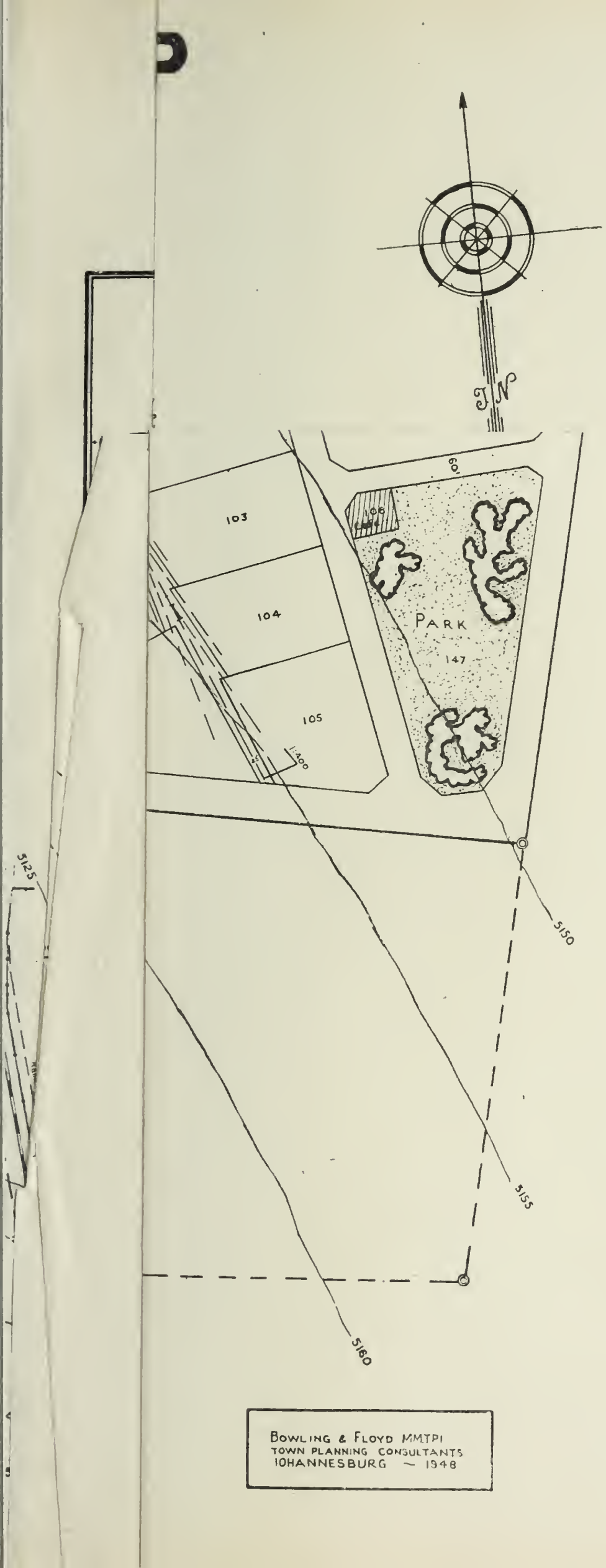
B



C

Fig. 15

RAILWAY SIDINGS



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LENZ INDUSTRIAL TOWNSHIP

SITUATE ON REMAINING EXTENT OF PORTION A OF PORTION OF THE
FARM RIETFONTEIN 48 DISTRICT KRUGERSDORP

SCALE-1:2,500

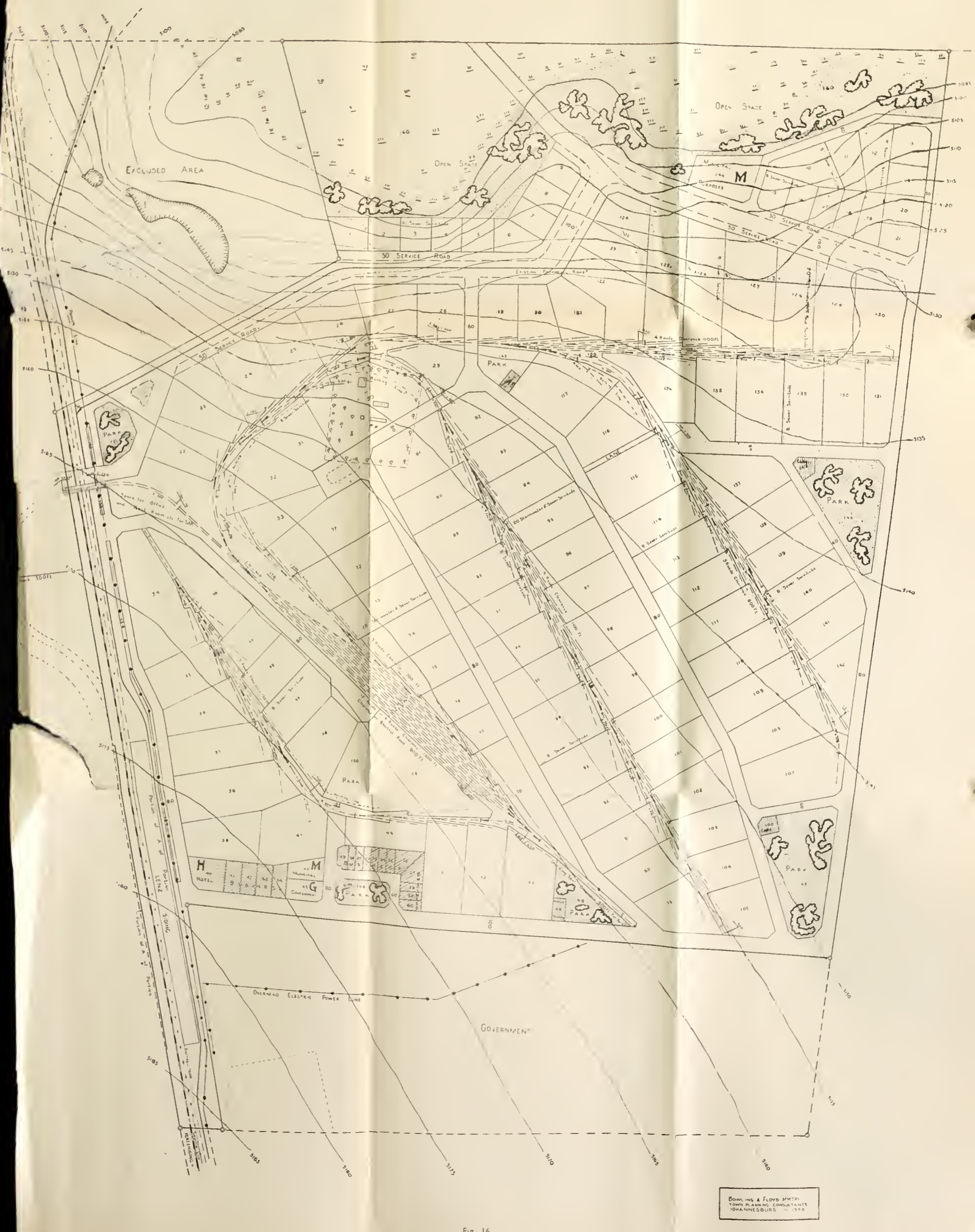
REFERENCE

- EXISTING PROVINCIAL ROADS
- TOWNSHIP ROADS
- RAILWAY RESERVES
- OPEN SPACES
- ERVEN FOR OFFICES AND BUSINESS
- HOTEL SITE
- CAFES
- INDUSTRIAL ERVEN
- NATIVE TRADING

LENGTH OF ROADS	9.4 Miles		
AREA OF ROADS	45 Morgen	-	3.1%
AREA OF PARKS & OPEN SPACES	50 Do	-	12.5%
AREA OF RAILWAY RESERVES	21 Do	-	5.2%
AREA OF ERVEN	91 Do	-	48 %
AREA OF LAND NOT INCLUDED	91 Do	-	23 %
TOTAL	398 Do		

FIGURES GIVEN ABOVE ARE APPROXIMATE

N.B. MEASUREMENTS REFERRING TO RAILWAYS ARE IN ENGLISH FEET



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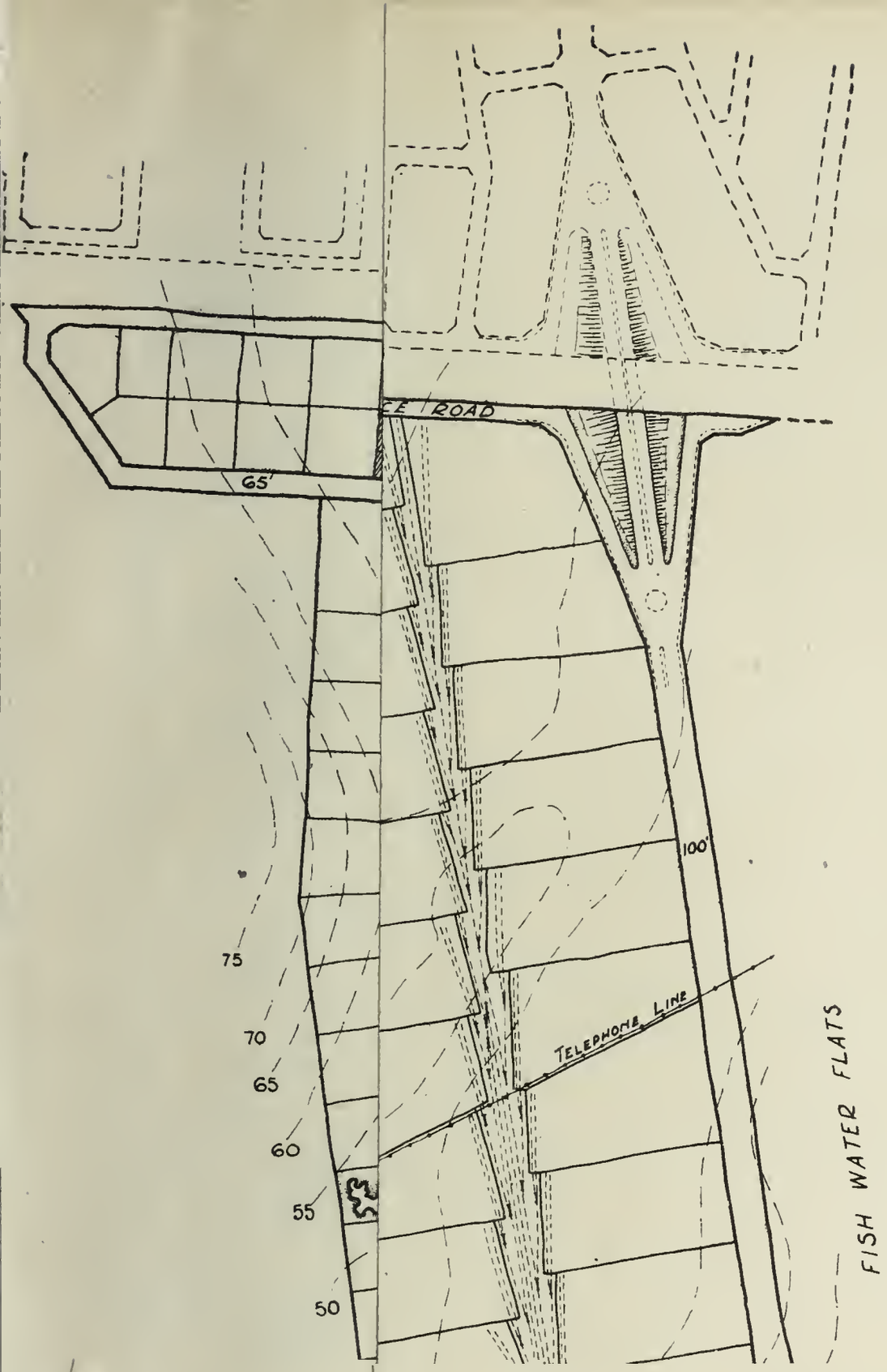
JOHANNESBURG — 1948

Fig. 16
LENZ INDUSTRIAL TOWNSHIP


CE ROAD
65'
100'
75
70
65
60
55
50
TELEPHONE LINE
FISH WATER FLATS

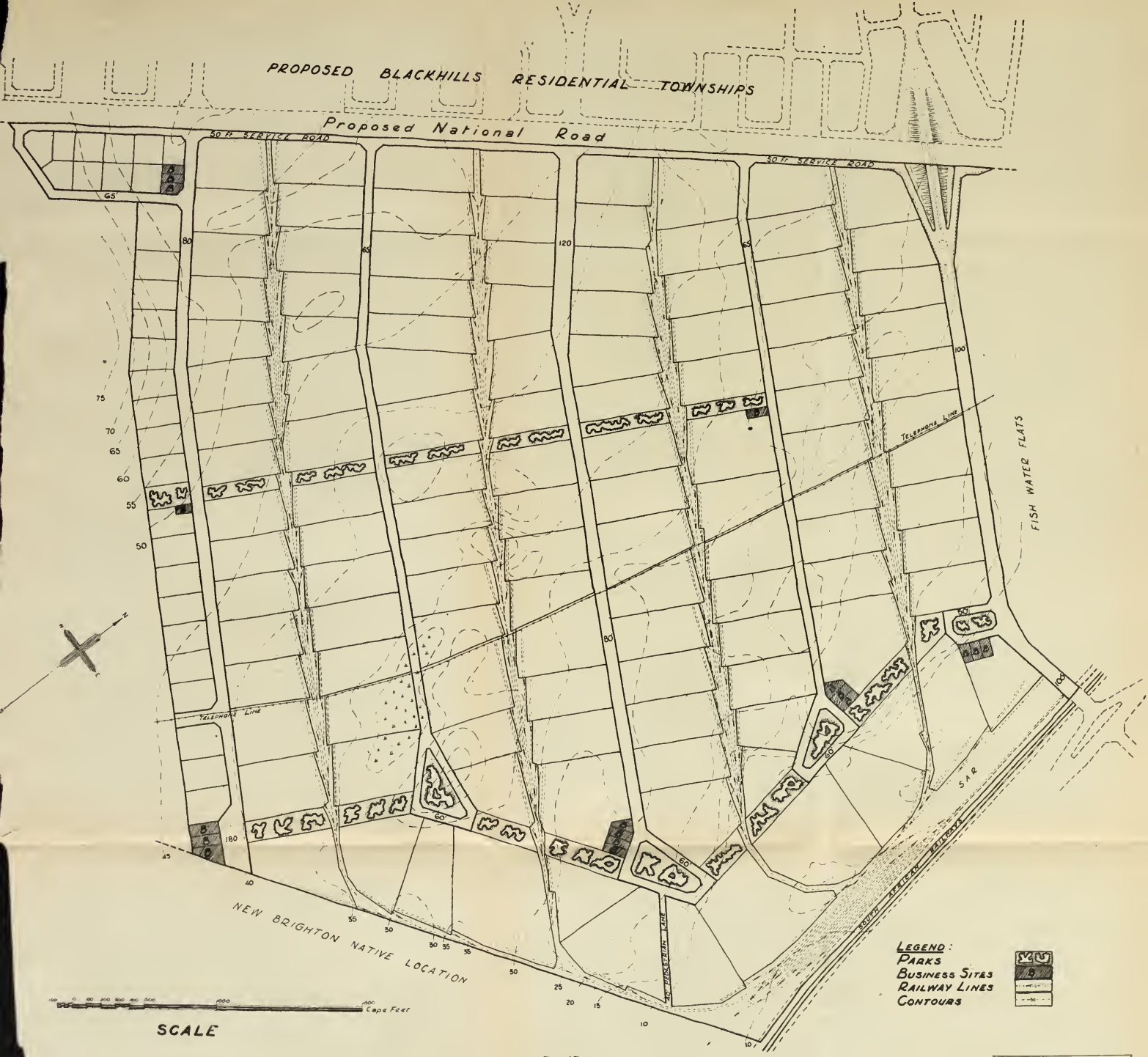


Fig. 17
PROPOSED LAYOUT OF ZWARTKOPS INDUSTRIAL TOWNSHIP

Designed by
Bowling & Floyd

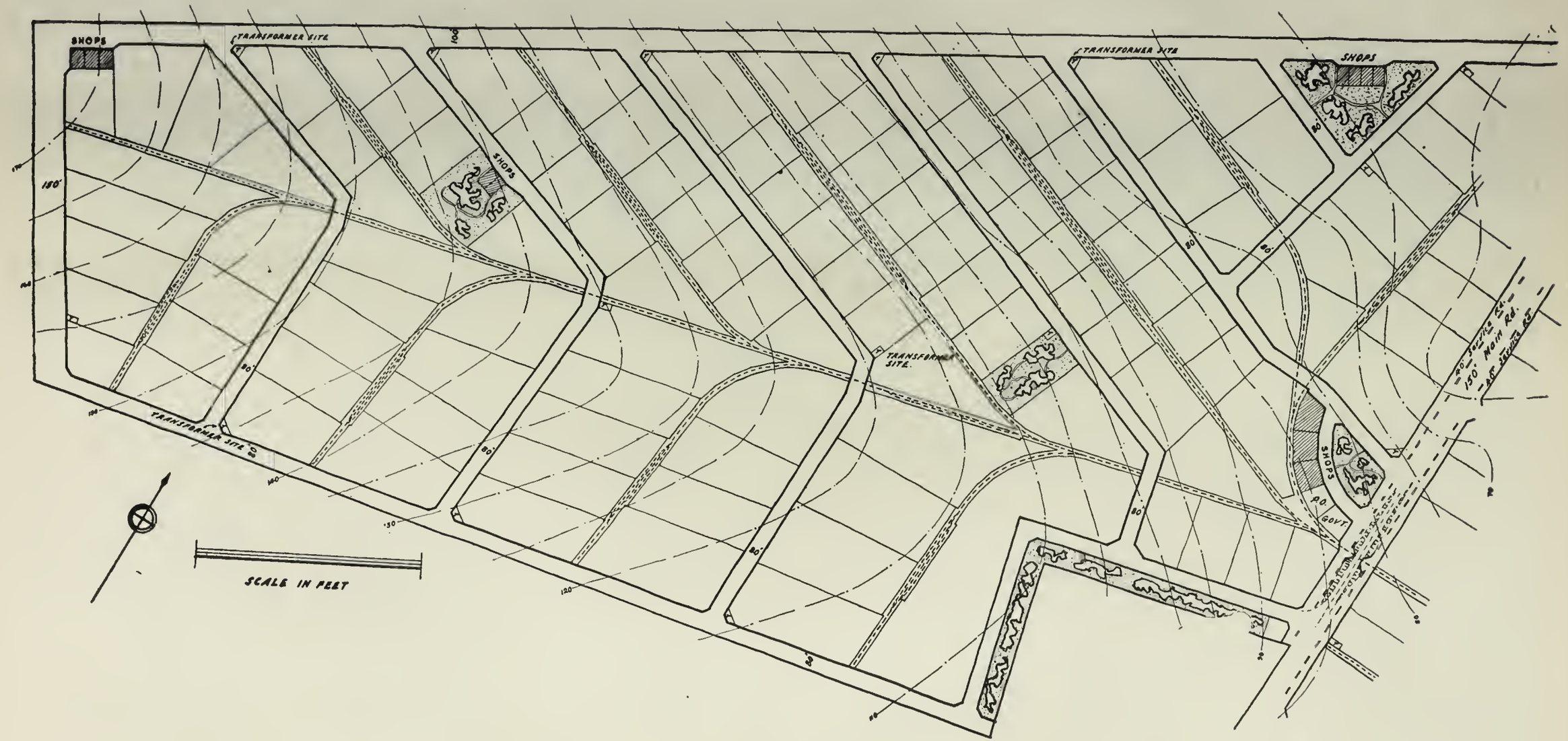


Fig. 18
PORTION OF ATRODE INDUSTRIAL TOWNSHIP

Designed by
H. Nielsen
Land Surveyor

be calculated. Underground water is not measurable although it may be known that certain localities have good supplies and others not.

The area allowed for plots in any locality should be determined by water supply and soil. If the soil is good and water supply good the minimum size allowed should be five morgen if dependent upon underground water supply and two morgen where there is a surface supply sufficient to properly irrigate at least one morgen per plot.

Where the water supply is doubtful but the soil is good, a minimum of ten morgen is suggested. In cases where the soil is only suitable as veld and the water supply doubtful an area of at least twenty-five morgen should be required.

The shape of plots depends on circumstances. Ordinarily a proportion of 1 to 4, where the depth is 4, is a good one. This may of course be departed from and long narrow plots created where there is a substantial advantage such as a river front to be gained by doing this. Plots must however not be too narrow, which means that they must not be of a width that will make ploughing difficult.

In the case of townships, erven are designed to face on to stream courses and these are planned in open space strips or stream walks, but with holdings the planning is just the opposite. Plots on holdings should be planned to back on to stream or water courses in order to be able to make full use of the water and to be sure that roads are on high ground and not in the valley bottoms where the earth or or gravel roads so easily become boggy in wet weather.

Roads in holdings are seldom other than earth or gravel roads and should therefore not have steep grades nor very flat grades. Grades of from 1 in 80 to 1 in 200 may be considered as ideal.

A social centre ought to be created in a layout for holdings. At present the law handicaps this in the Transvaal where nothing more can be attained today than the grouping together of the school, business plot and plot for public purposes. This forms but a poor centre particularly as no plot may be less than a morgen. Figure 19 shows the type of social centre that should be planned as the middle point of all holdings.

The proper solution of this problem is to design a good social centre in the form of a small village and then plan the holdings around this. Such a village centre ought to contain sites for shops, workshops, school, boarding houses, police, public hall and sometimes an hotel. There should be a number of residential sites for the dwellings of persons employed in the shops or school as well as for retired persons. A design of this type prepared for a site near to East London is illustrated in Figure 20.

Sanitation of holdings is a totally different proposition to that of towns or suburbs. The bucket system is expensive and very conducive to fly-breeding. For these reasons it should not be used except under special circumstances. Septic tanks are usually neglected and the liquid from them is very liable to cause a nuisance or pollute water supplies from wells, rivers, dams and boreholes.

The best system of sanitation for holdings is pit privies or chemical closets. Waste water can easily be dealt with and so can refuse on an area of land an acre or over in size.

Another example of holdings is shown in Figure 21. This includes an area supplied with water for irrigation from an adjacent river which is dammed back. The irrigated holdings are 3 acres in area and the others 5 acres and larger.

5. NATIVE LOCATIONS

The term " location " means an area set aside for occupation by Natives and may be a rural Native reserve or settlement, a Native village or " stat " or a municipal location. It is this latter that is referred to in this chapter.

In the western Cape Province among the older towns municipal locations are either non-existent or have only recently been established.

Municipal locations came into being as areas where Hottentots or Kaffirs resided when they left their tribal kraals to seek work as domestic servants or unskilled labourers among Europeans in towns. They provided a temporary abode for such Natives. Stray Natives from tribes broken up by pestilence or war, also drifted to these locations, but their residence was more of a permanent nature.

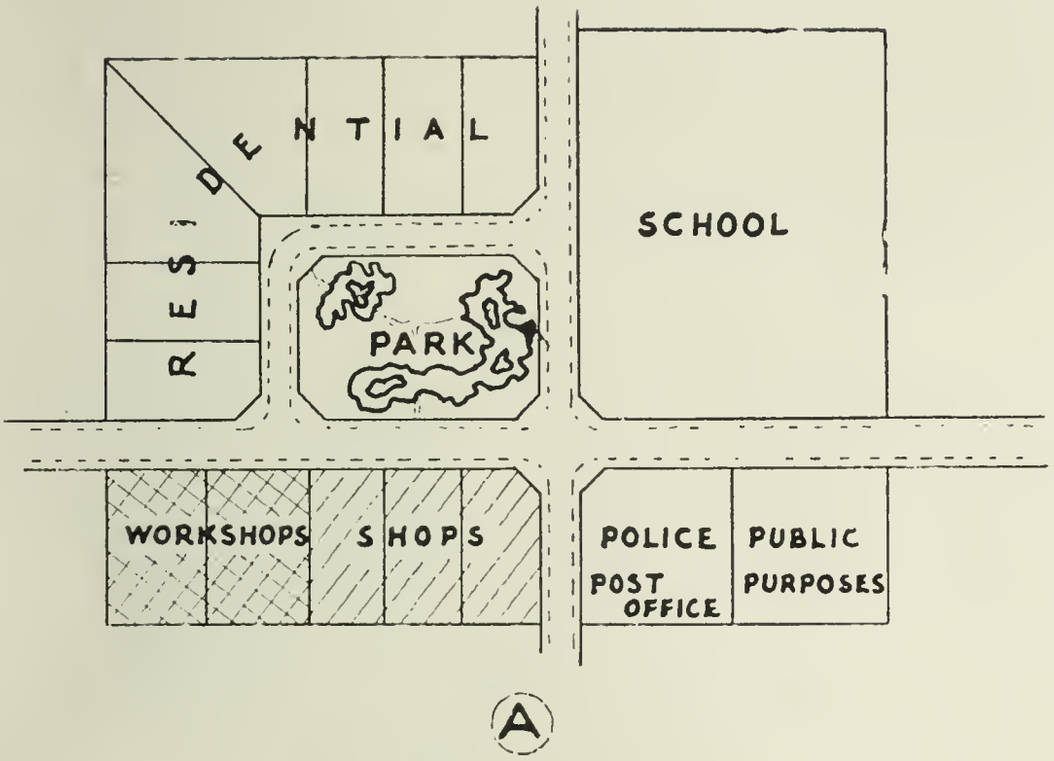
At first locations grew as a collection of huts built by these Natives without any order or control. As they grew it became necessary for local authorities to provide sanitation and other essential services. In order to make this possible some order was essential and this led to the layout of locations. A gridiron pattern with streets 20—40ft. wide and stands of roughly 50×50ft. was usual.

The general appearance of these old locations is bad. From a disorderly mass of huts locations were changed to monotonous rows of shacks or rooms either built by the Natives, Europeans or the local authority. No centres or parks were planned or developed to break the barrack-like monotony of rows of small dwellings.

One must however not be deceived into believing that good and attractive layouts will entirely remove all the drab locations, for this is not so. In many areas of the country the rainfall is so poor that the lack of water and therefore of trees and plant growth will always leave locations somewhat drab.

Three factors need very strict control if well laid out locations are not to be spoilt. One is the keeping of goats and animals by Natives, the second is the gathering of scrap and the erection of fences and sheds with such scrap and the third is the siting of the houses. These last need not necessarily be sited in rows even when streets are straight and regular. Figure 22 illustrates how this can be done.

Every effort should be made to provide ample open space and parks to break up the monotony and dense appearance. The design



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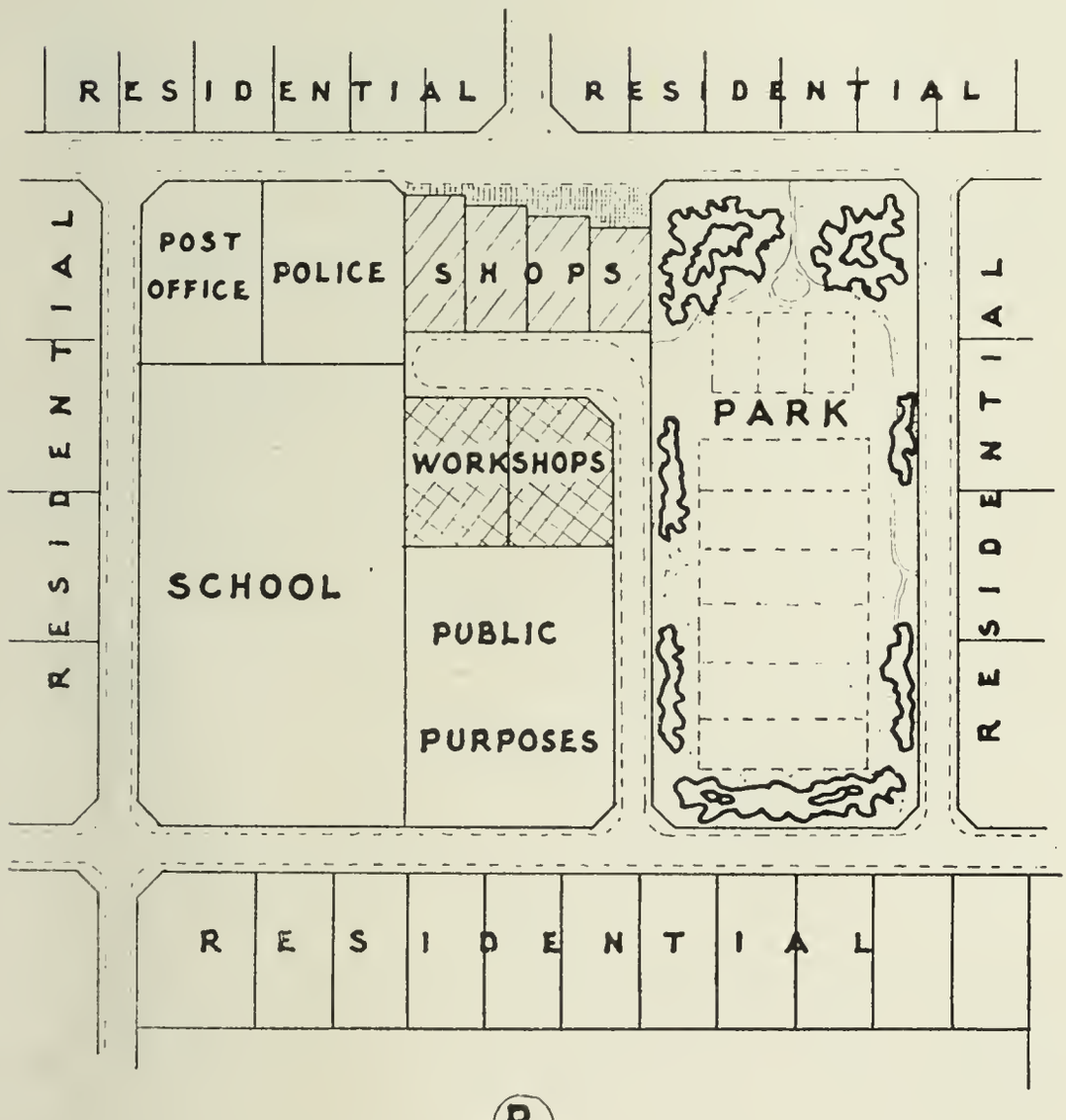


B

Fig. 19
SOCIAL CENTRES FOR HOLDINGS

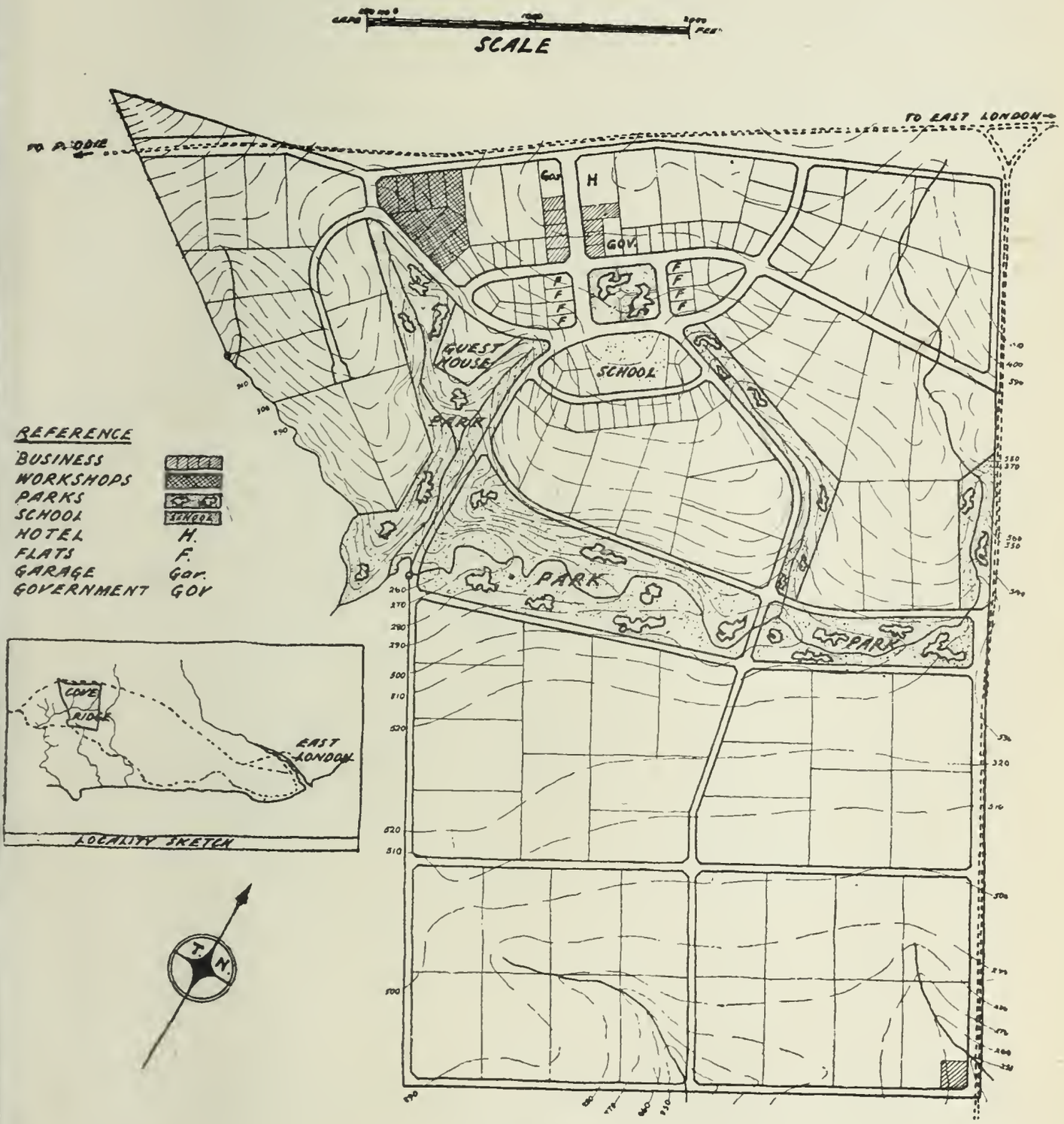


Fig. 20
COVE RIDGE, EAST LONDON

Designed by
Bowling & Floyd

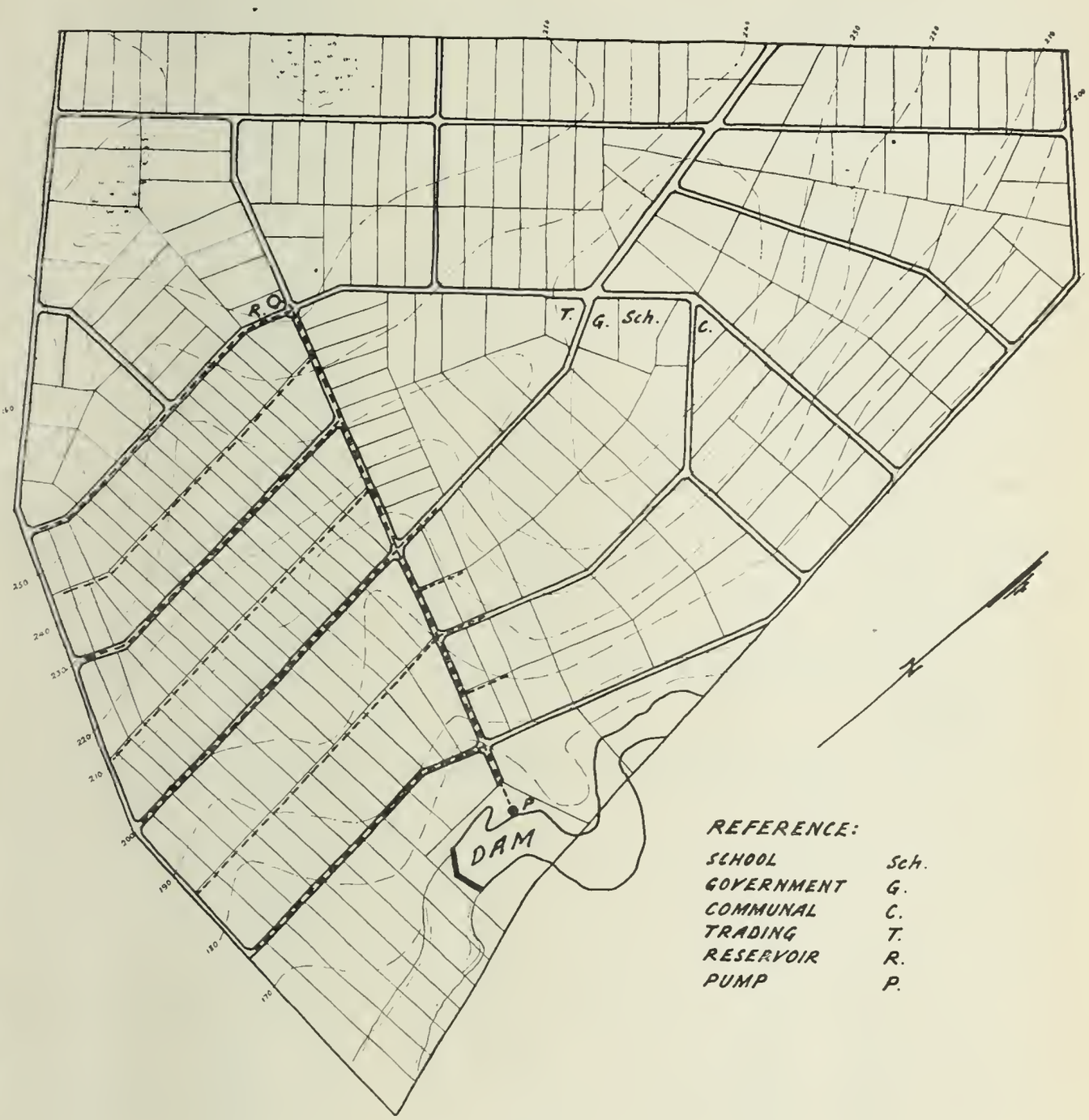


Fig. 21

HOLDINGS WITH IRRIGATION—CAWDOR AGRICULTURAL HOLDINGS

Note.—Heavy dotted lines show proposed irrigation pipe lines.

Designed by
Bowling & Floyd

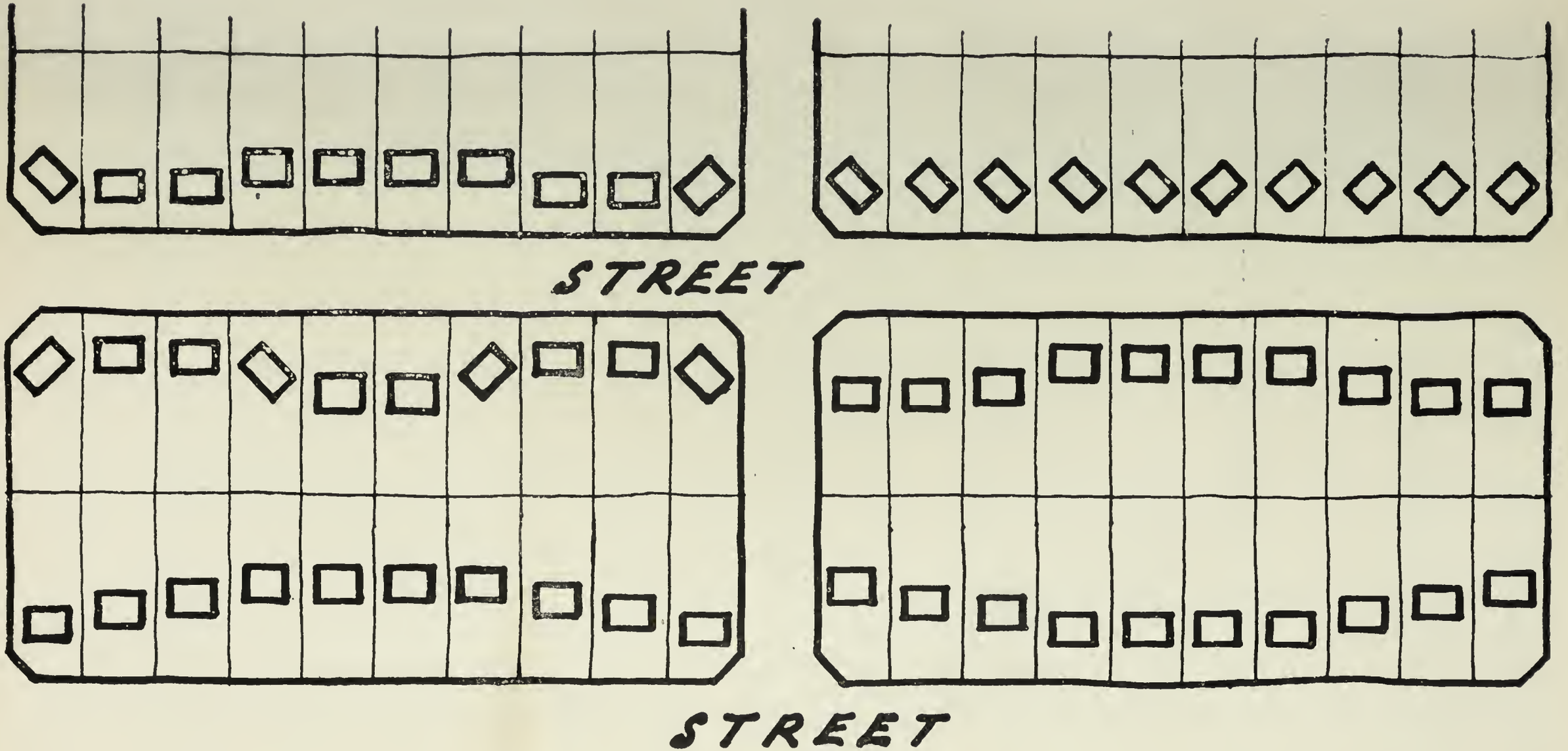


Fig. 22

SET BACK OF HOUSES FROM STREET LINES IN LOCATIONS

should create interest. Native styles of hut design should be introduced wherever possible and the layout should enable such to take place.

Few if any locations pay their way and housing if embarked upon by the local authority is usually sub-economic. For these reasons it is essential that strict economy be practised when designing municipal locations.

The greater the economy affected in services, the more will be the amenities that may be provided.

As a reaction against the small stands and congested areas of the past it is now common to provide stand sizes of 60×80ft. and 50×100ft. The former size is far too extravagant of frontage and even the 50×100ft. although more economical still results in fairly high costs of development. The Native Affairs Department requires a size of at least 50×75ft. and regards 50ft. as the minimum frontage.

Too small a stand size cannot be used for Natives because picannins do not use the closets but make use of the ground around the houses. This habit makes a garden essential. Apart from this crude practical reason the massed, dense effect created by small stands should be avoided. Natives will appreciate and make full use of a garden where water is available or the rainfall allows this.

A size giving sufficient garden and yet not overtaxing the cost of services too much is 40×80ft. This size of stand will economise roads and services by about 25% as against the 50×100ft. and 30% as against the 60×80ft. stand size. It will effect a saving of 15% over the old 50×50ft. stand size and nearly 20% over the standard size of the Native Affairs Department. Apart from the reduction in cost of services a stand size of 40×80ft. will reduce land cost by 30% as against a stand size of 60×80ft.

Most of the principles involved in the layout of residential townships for Europeans apply equally to Native locations but in certain respects there are differences and these need special consideration when planning.

There is very little traffic in municipal locations except that of refuse and sanitary vehicles, delivery vehicles, hawkers and a few motor cars. No traffic problem really ever arises. No thought need be given to servants' rooms and the other problems of European residential areas where black and white live on the same erven.

Roads in locations are seldom constructed beyond being gravel or earth graded roads. This means that gradients must be carefully studied and may not be as steep or as flat as permissible in European areas. Steep grades will result in the scouring out of furrows in roads. Because of this and the added cost of building foundations steep sites should be avoided for municipal locations.

The administration of locations is on different lines to that of European areas of a town. The "headman" principle is often adopted and this is facilitated if houses are grouped into units and these units into super-blocks.

Road-bays in European townships as will be shown in Chapter IV increase the cost of services somewhat but in municipal locations, where no motor access is needed to every stand, they may be used to advantage. Under such circumstances they will enocomise road making and the cost of providing services. Figure 23 shows a layout of a location for Potchefstroom. In this design the road-bay system was largely used. The layout has been adapted to the topography of the site and an ample provision of open space has been made. A local centre with a large open square for meetings has been embodied in the layout and provision has been made for an indusrtial area adjacent to the business centre. This industrial zone is intended for small industries and workshops and will result in power distribution being located at one spot and thus economised.

Figure 24 shows a layout design for a new location at Worcester The site is flat and thus lends itself to a formal design. Road-bays are used and the layout follows the lines of the Potchefstroom design. Care was needed in order to assure that roads could be drained.

Figure 25 shows a large new location planned for Pretoria. The main features of this design are the radiating primary road pattern and internal development of blocks.

Full advantage is taken of the fact that little traffic occurs on the local roads of a location. The use of internal development has resulted in a great saving of road area.

Ample provision is made for open spaces and school sites in the layout.

4570
4560
4550
4540
4530
4520
4510
4500
4490

POTCHEFSTROOM MUNISIPALITEIT MUNICIPALITY

PROPOSED NEW LOCATION
VOORGESTELDE NUWE LOKASIE

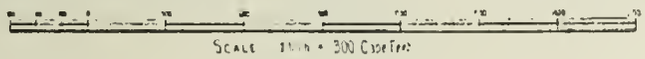
SKAAL/ SCALE - 1:5000

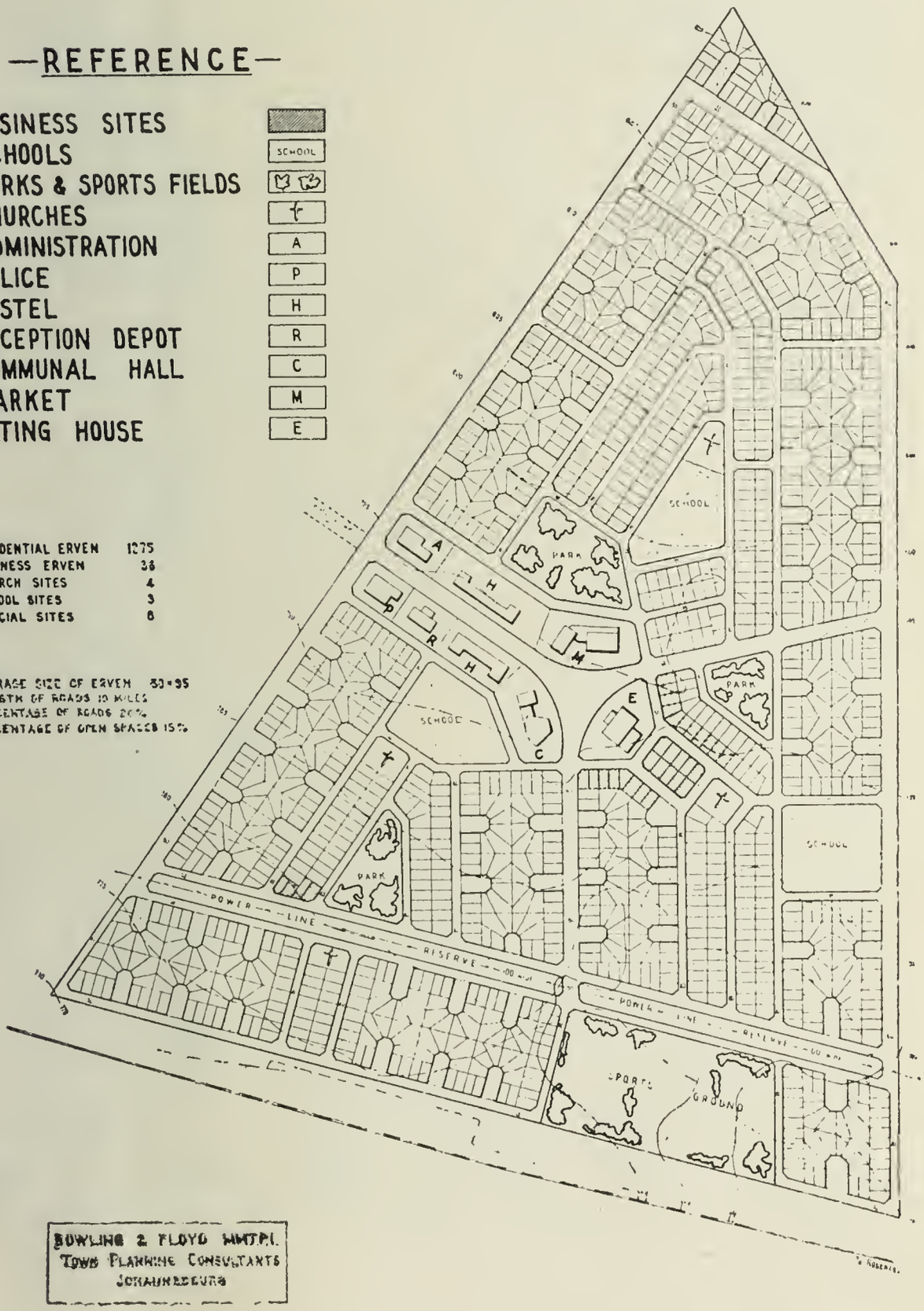
Fig. 23

WORCESTER MUNICIPALITY

LAYOUT OF

PROPOSED NEW LOCATION





BOWLING & FLOYD (PTY) LTD.
TOWN PLANNING CONSULTANTS
JOHANNESBURG

Fig. 24

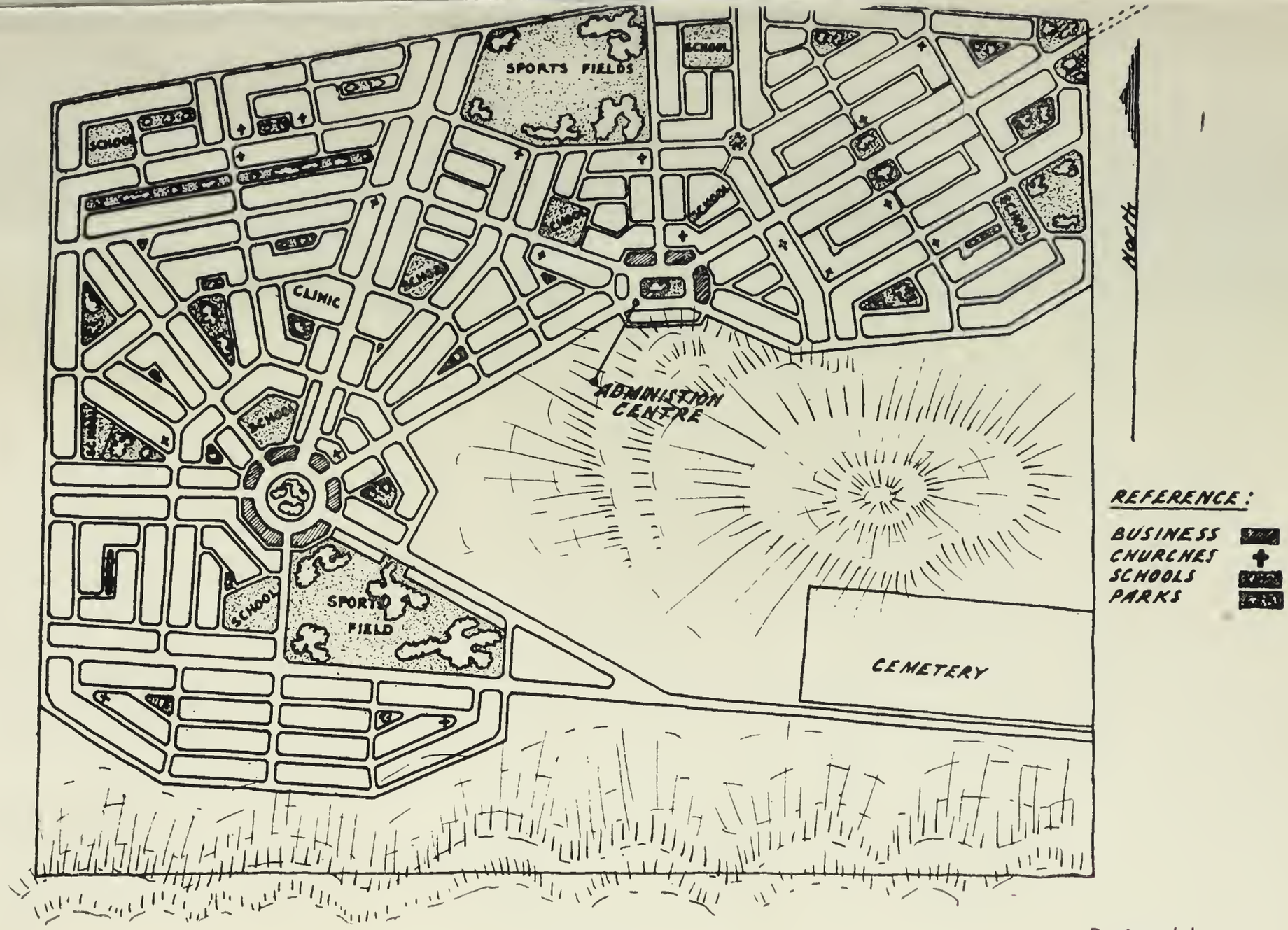


Fig. 25
PRETORIA LOCATION

Designed by N. T. Cooper of City Engineer's Dept. Pretoria in collaboration with the Witwatersrand & Pretoria Regional Planning Office

Chapter IV

ECONOMIC STUDY OF LAYOUTS*

A study was carried out by the author to ascertain the effect of various forms of layout of suburban townships on the cost of roads and major services. Six different layout designs were prepared for the same site, which was a super-block as provisionally designed in the main road framework of Vanderbyl Park.

These super-blocks are approximately half-a-mile by half-a-mile in size and are surrounded by main roads 150ft. wide, which formed part of the main road framework of the town.

The size of the super-blocks was determined by the author, when designing the main road network of Vanderbyl Park, to be such that traffic and transport could be conveniently and economically canalised whereas at the same time a convenient residential unit resulted. The super-blocks were not intended for neighbourhood units as a development of this nature would be undesirable in an ordinary size town.

Each of the designs are therefore layouts for a residential unit or suburban township. They all conform as far as possible to the following requirements in order that a common basis of comparison is provided :—

Main local feeder roads 60ft. wide.

Other local roads 50ft. wide.

Size of erven 70×100ft.

Area of school site 7 acres.

Public open spaces including school site to be approximately 10% of the total area of the township.

The site selected is featureless, with a gentle slope but in places flat enough to make drainage somewhat difficult. Thus to obtain north-facing erven and yet provide for good drainage became very difficult. The contours are such that drainage is easier if east-west frontage erven are planned.

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*Thanks are due to Messrs. R. Kantorowich and I. Aronson for their assistance in this study.

The six study designs prepared are as follows :—

Figure 26,Layout No. 1—Long blocks and continuous local roads.

Figure 27, Layout No. 2—Internally developed blocks.

Figure 28, Layout No. 3—Cul-de-sac roads.

Figure 29, Layout No. 4—U-loops with ends on public open spaces.

Figure 30, Layout No. 5—U-loops with ends closed by erven.

Figure 31, Layout No. 6—Gridiron layout.

Layout No. 1—Long Blocks and Continuous Local Roads

This form of layout is at present very commonly used with or without variations. It can be adapted to suit any topography and as used in the study suits the site in question very well. No difficult problems are created for roadmaking, drainage, sewerage, or the supply of other services. No more flexible form of design is known.

Such a layout may be designed to discourage through traffic whilst at the same time giving direct access to the important centres and places of employment.

In the study layout the parks are in large areas and thus have a wide range of use as well as being economical in upkeep. This form of design enables one to avoid small scraps of parks if it is desired to do so.

When used for small cottage development, on small erven, the long straight rows produce a somewhat monotonous result particularly where the houses are designed by the same person on housing scheme lines.

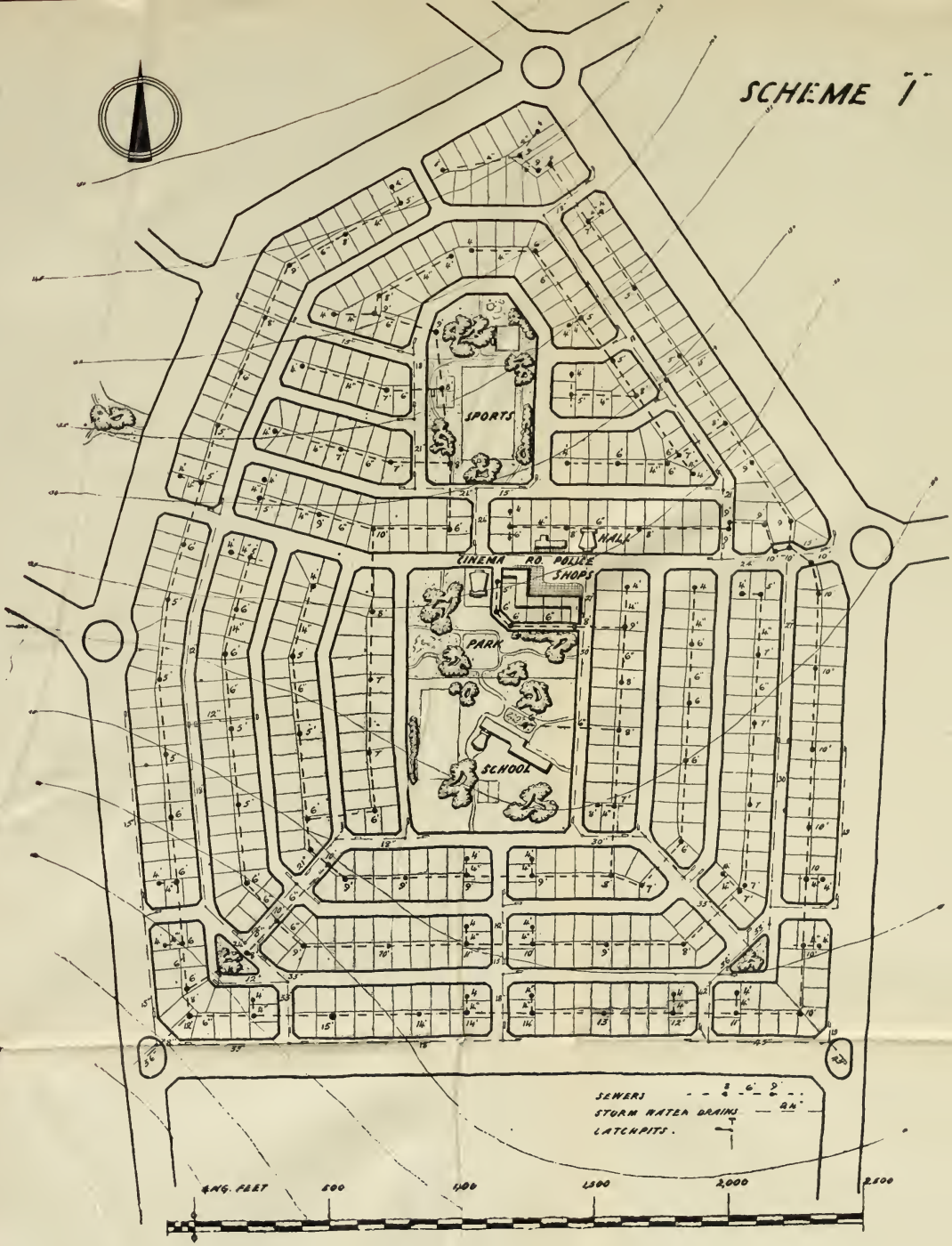
Layout No. 2—Internally Developed Blocks

In study layout No. 2 internal development is used in a form which may correctly lead one to regard this design as a variation of layout No. 1.

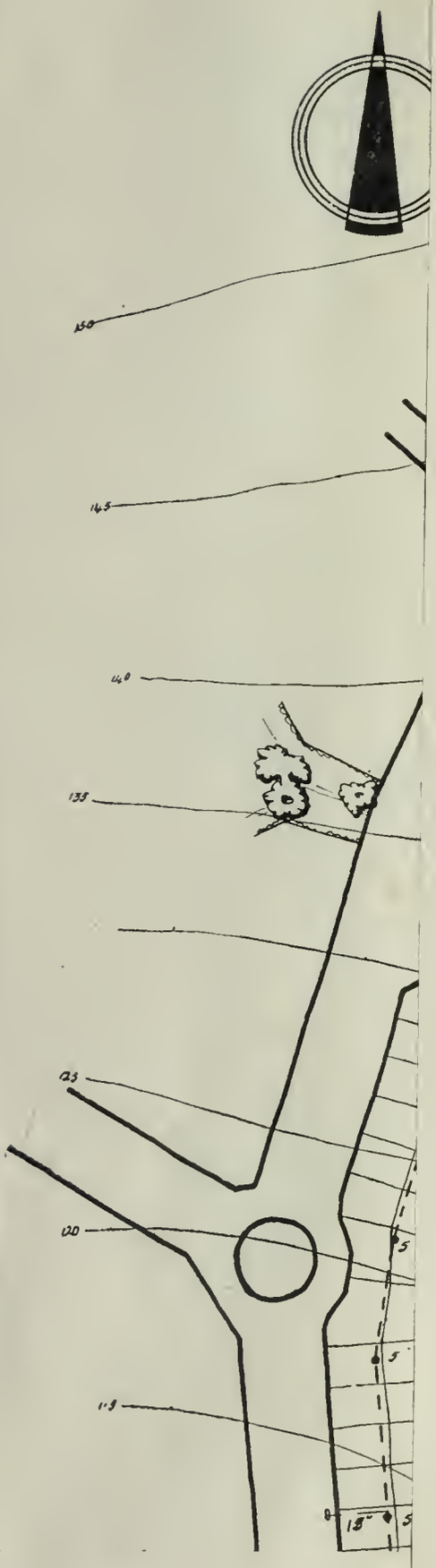
Internal development creates quiet residential precincts and allows some form of grouping where erven are small. A small park or playground may easily be planned in the blocks in such a manner that children may play within sight of their home.

By breaking up the public open space area into small units they may be spread about the township and where erven are small this tends to break up the dense effect. There is however a resultant loss of road frontage for building purposes and the variety of uses to which the public open spaces may be put is reduced. Maintenance costs are considerably increased by breaking up the public open space area into small units.

In this form of layout the internal frontage of the blocks are more attractive than in Layout No. 1 but on the external frontage there is no difference in appearance.


SCHEME 1
SPORTS
HALL
CINEMA
P.O.
POLICE
SHOPS
PARK
SCHOOL
SEWERS
STORM WATER DRAINS
CATCHPITS.
ENG. FEET
500
1,000
1,500
2,000
2,500

Fg. 26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145
140
135
125
120
115
0
18'
5
5

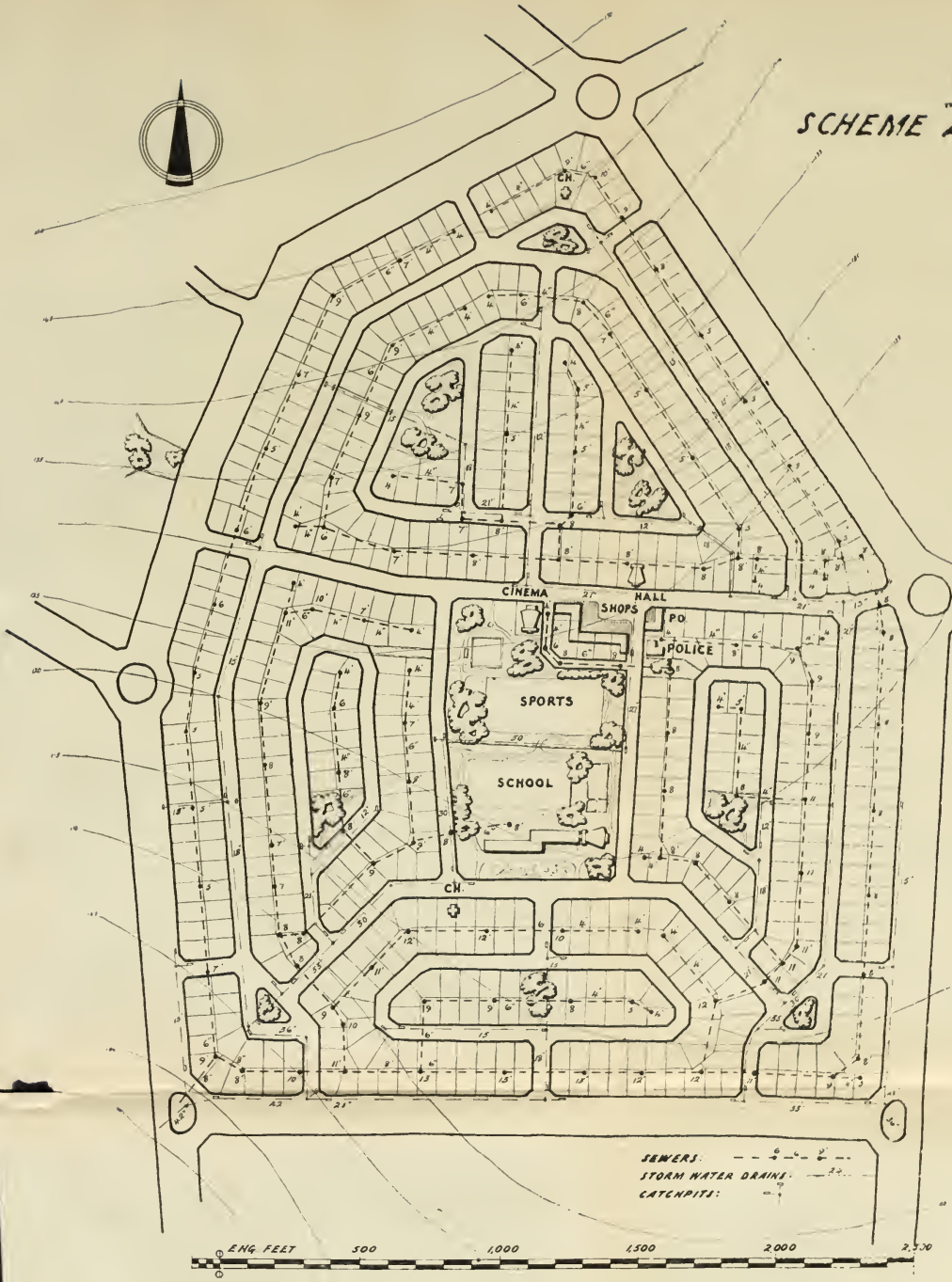
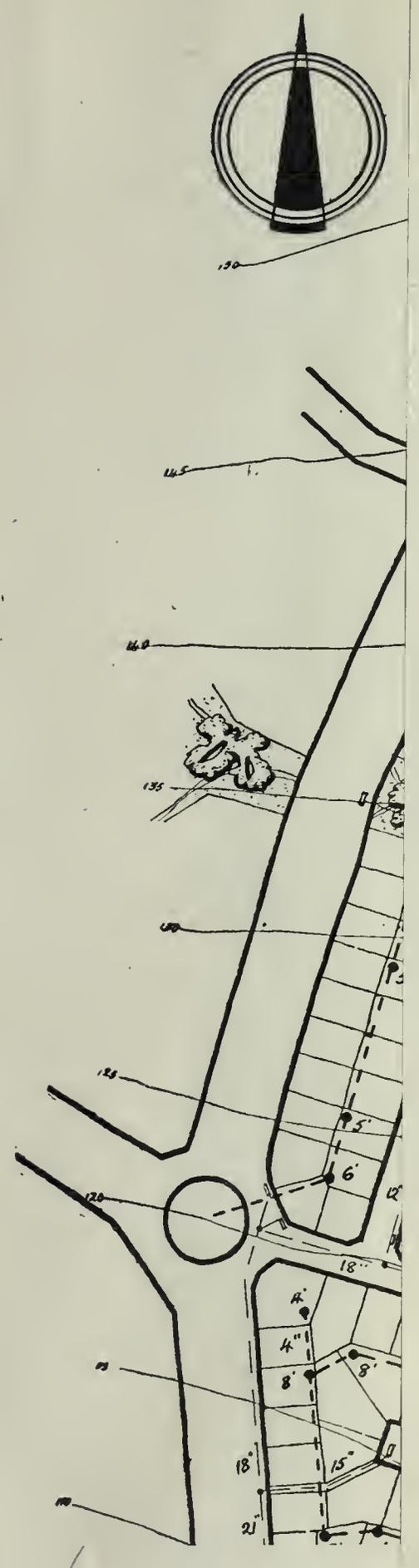

SCHEME "2"
CH.
CINEMA
HALL
SHOPS
P.O.
POLICE
SPORTS
SCHOOL
CH.
SEWERS:
STORM WATER DRAINS:
CATCHPITS:
ENG. FEET
500
1,000
1,500
2,000

Fig. 27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140
135
125
120
6'
5'
18"
4"
4"
8'
8'
18"
15"
21"

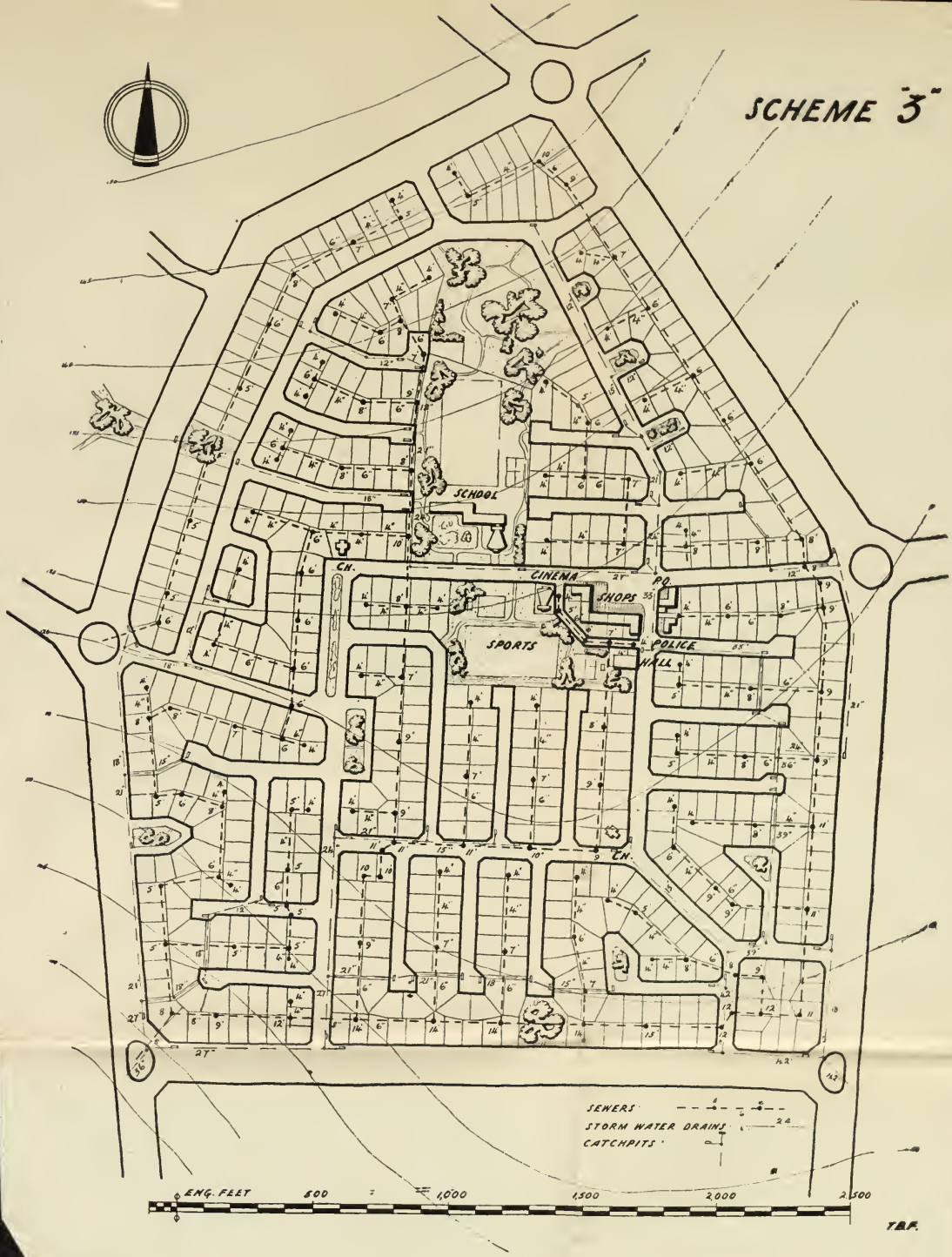
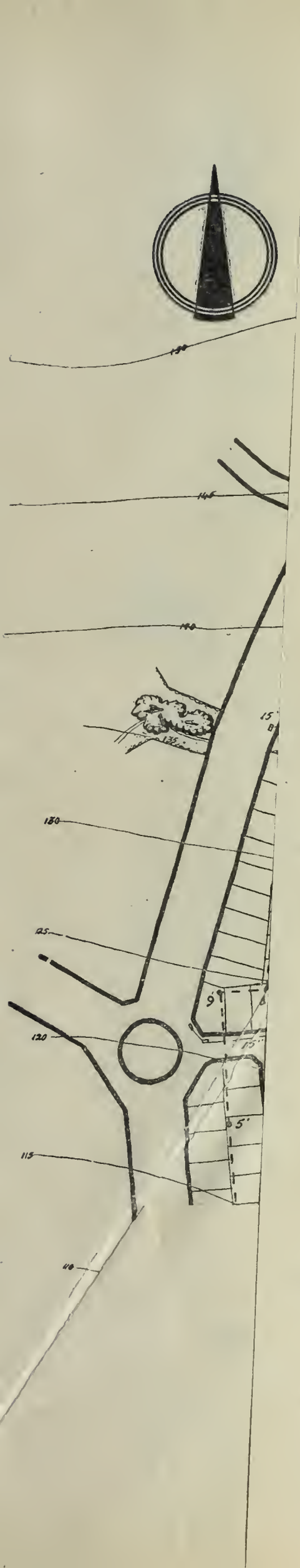

SCHEME 3"
SCHOOL
C.H.
CINEMA
P.O.
SHOPS
SPORTS
POLICE
HALL
C.H.
SEWERS
STORM WATER DRAINS
CATCHPITS
ENG. FEET
500
1,000
1,500
2,000
2,500
T.B.F.

Fig. 28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145
150
135
180
125
120
115
110
15'
9'
15'
5'

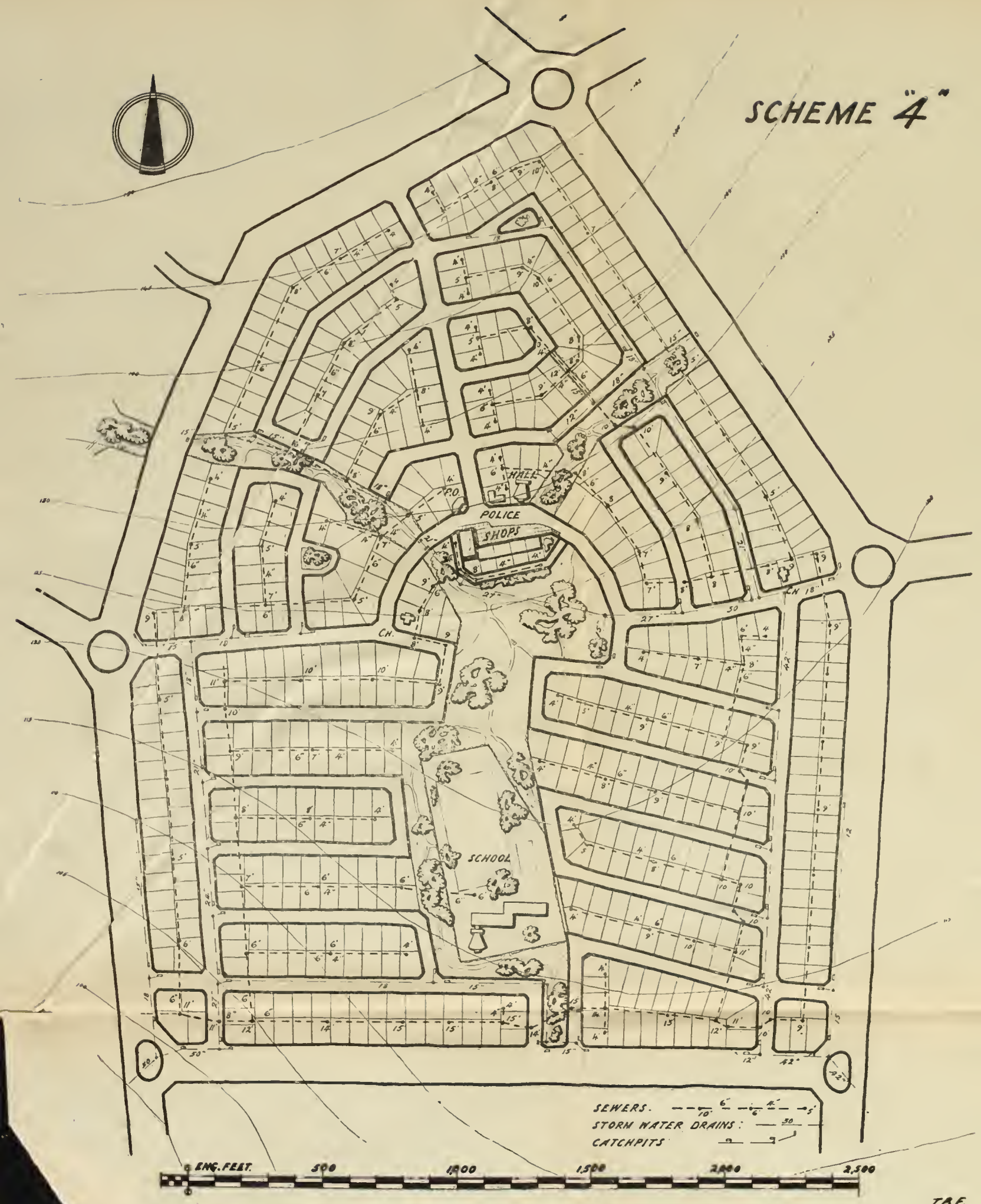
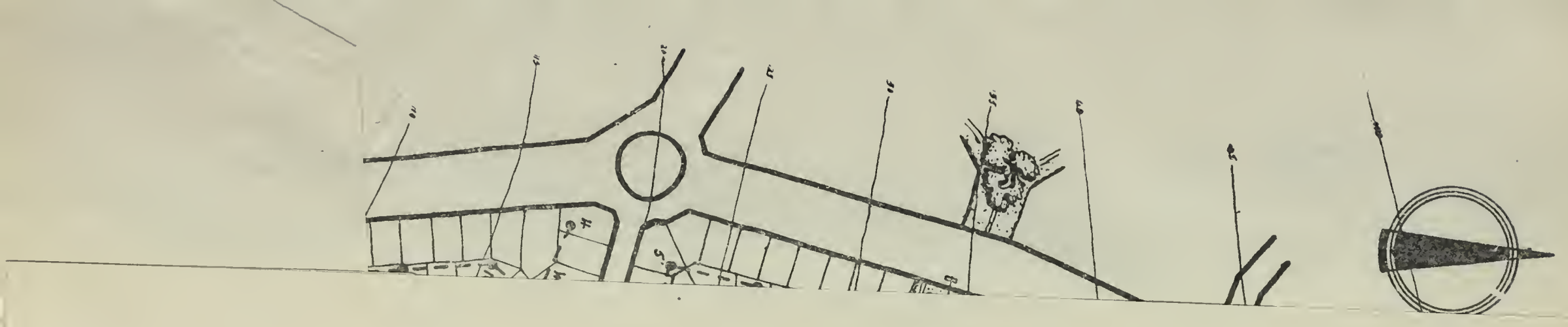

SCHEME "4"
HALL
P.O.
POLICE
SHOPS
CH.
SCHOOL
SEWERS.
STORM WATER DRAINS :
CATCHPITS
0 ENG. FEET. 500 1,000 1,500 2,000 2,500
T.B.F.

Fig. 29



SCHEME 5
SCHOOL
CINEMA
SHOPS
HALL
SEWERS.
STORM WATER DRAINS:
CATCHPITS:
FEET
500
1,000
1,500
2,000
2500
DESIGNED : R. KANTOROWICH

Fig. 30

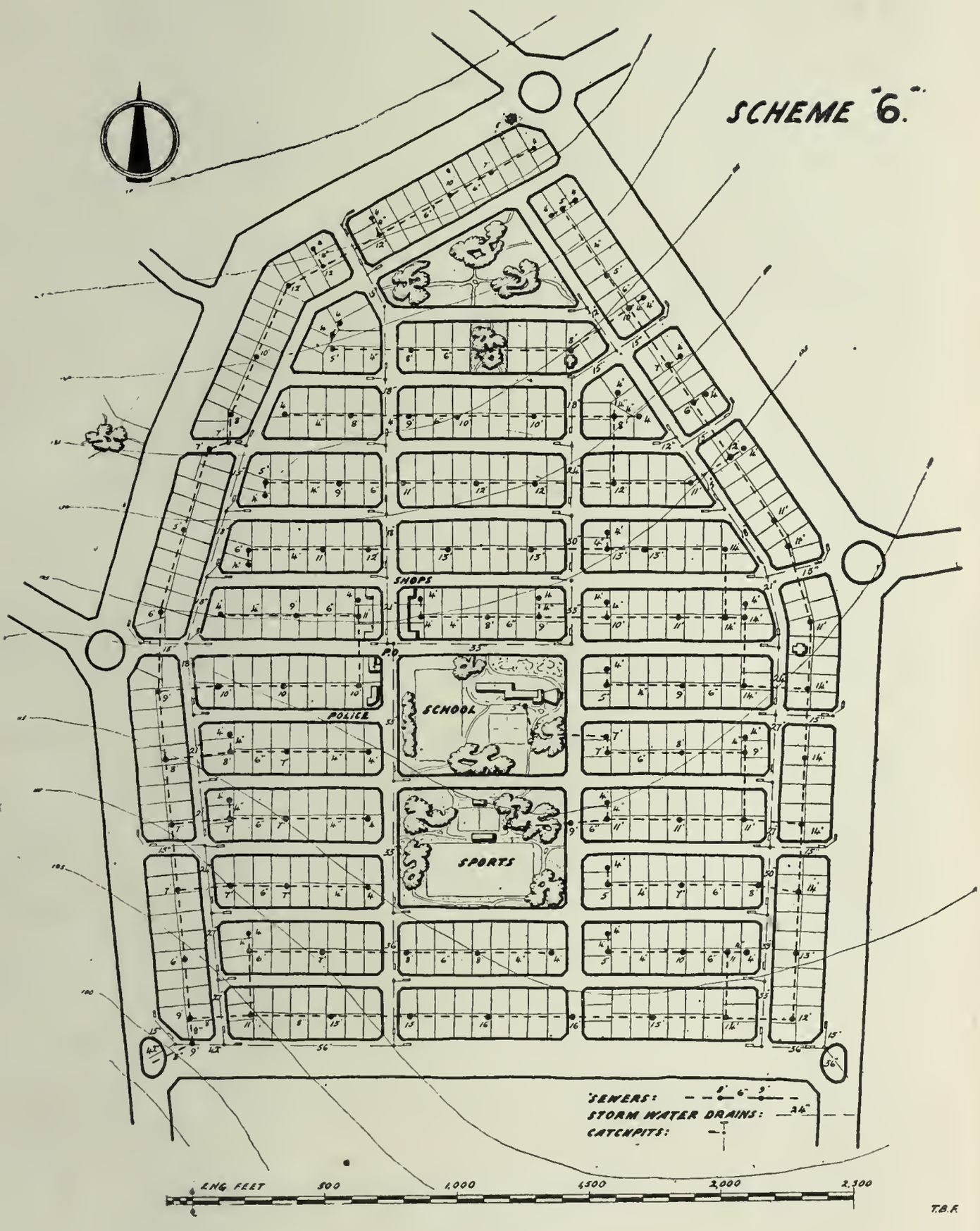

SCHEME "6."
SHOPS
P.O.
POLICE
SCHOOL
SPORTS
SEWERS:
STORM WATER DRAINS:
CATCHPITS:
ENG FEET
500
1,000
1,500
2,000
2,500
T.B.F.

Fig. 31

Layout No. 3—Cul-de-sac-Roads

If culs-de-sac are used on a large scale they result in a very inconvenient form of layout. Delivery and other vehicles are forced to return on their tracks and thus doubling up their running miles with a resultant increase in traffic movement. The backing of large vehicles when turning in these culs-de-sac results in an element of danger to children on these roads.

It is a system of layout that restricts through traffic but it does so at the expense of an easy flow of same.

Stormwater troubles are prone to arise in layouts on this method. To overcome such troubles servitudes or lanes for drainage become necessary.

Public open spaces and parks may be dealt with as desired when this system of layout is used.

Although Layout No. 3 may appear very different to study No. 1 either on paper or when models are made, it will present the same appearance when built up.

Layout No. 4—U-Loops with Ends on Public Open Spaces

In a layout of this type traffic will circulate far better than in that of No. 3 but not as freely as in the case of layouts Nos. 1 and 2.

It allows the open space area to be arranged in a system which will provide access walks to the shops and school as well as facilitating the creation of quiet precincts.

The ending of the U-loops on public open space creates pleasant features and brings every house within easy reach of such an open space but it adds to development and maintenance costs. If the ends of the loop are linked by roads the traffic flow is improved but the costs of road making and services are increased.

When topographical features such as wooded streams, hills or ridges exist this type of layout makes it easy to preserve these in public spaces or parks and thereby allows the creation of pleasant vistas at the ends of streets. In this respect study layout No. 4 is to be preferred to Nos. 1, 2 and 3.

Stormwater drainage and sewerage may be easily and effectively dealt with in this form of layout. On broken sites particularly, does this advantage make itself obvious.

Layout No. 5—U-Loops with Ends Closed by Erven

Although this method lowers costs of development as compared with study layout No. 4 the advantages of the vistas on to parkland are lost. This loss will of course vary according to the natural features of the site. On flat featureless country such as that used for these study layouts it amounts to very little.

In this study layout the public open space area has been largely consolidated into large central parks. This is however not inherent in designs of this form and small open spaces scattered about or park strips could easily be embodied if so desired.

Sewerage and stormwater difficulties may be created but can be overcome by means of drainage lanes or servitudes.

Layout No. 6—Gridiron Layout

A well designed gridiron pattern, which was adapted to the shape of the super-block and avoided much of the wastage in road so common to these layouts, was used in this study. This was done to give this form of layout a good chance in the economic comparison of the different layouts. The gridiron layouts commonly found with unfinished ends and numerous triangular blocks would not come anywhere near to the study as regards development costs.

It is easy to set out the erven and blocks in the gridiron layout. Such a layout also simplifies water and electricity reticulation and allows them to be simply constructed, but it often creates serious road and drainage problems.

The super-block idea of canalising traffic does not work happily with this form of design nor is it possible to design a local centre which is the proper focal point of the layout.

Layouts of this type are particularly lacking in interest.

Economic Comparison

The first step in the comparison of these layout designs is to find out the percentage of road area devoted to public open space as well as the number of erven and road length. These figures are given in Table D.

An examination of this table will reveal that study layout No. 3 gives the greatest percentage of land devoted to erven and the lowest percentage of road area. In spite of this it gives the least number of erven *i.e.* 637. This is due to the loss of land resulting from the fan-shaped erven at the ends of the culs-de-sac.

Study layout No. 1 gives the greatest number of erven i.e. 677, but Nos. 2 and 6 are close to this with 675 and 673 respectively. Layout No. 4 gives a low number of erven and a high road area as well as a high percentage of public open space. If the open space area is considered then No. 4 does not greatly differ from No. 5 and is not as far behind Nos. 1, 2 and 6 as would at first sight appear to be the case.

The analysis in Table D does not give sufficient data on which an opinion as to the most economical of the six designs may be based. It is therefore necessary to carry the study a step further.

In Table E the development costs or costs of services are worked out per erf. Of these costs it will be seen that the cost of the roads is the greatest when land costs £100 per acre, but it would remain so until the land cost exceeds £300 per acre. £100 per acre was taken as a land cost figure because it gives a unit from which any figure for various land costs may easily be deduced.

Study layouts Nos. 3 and 6 do not show up well in Table D and this opinion is confirmed in the results of Table E. With a

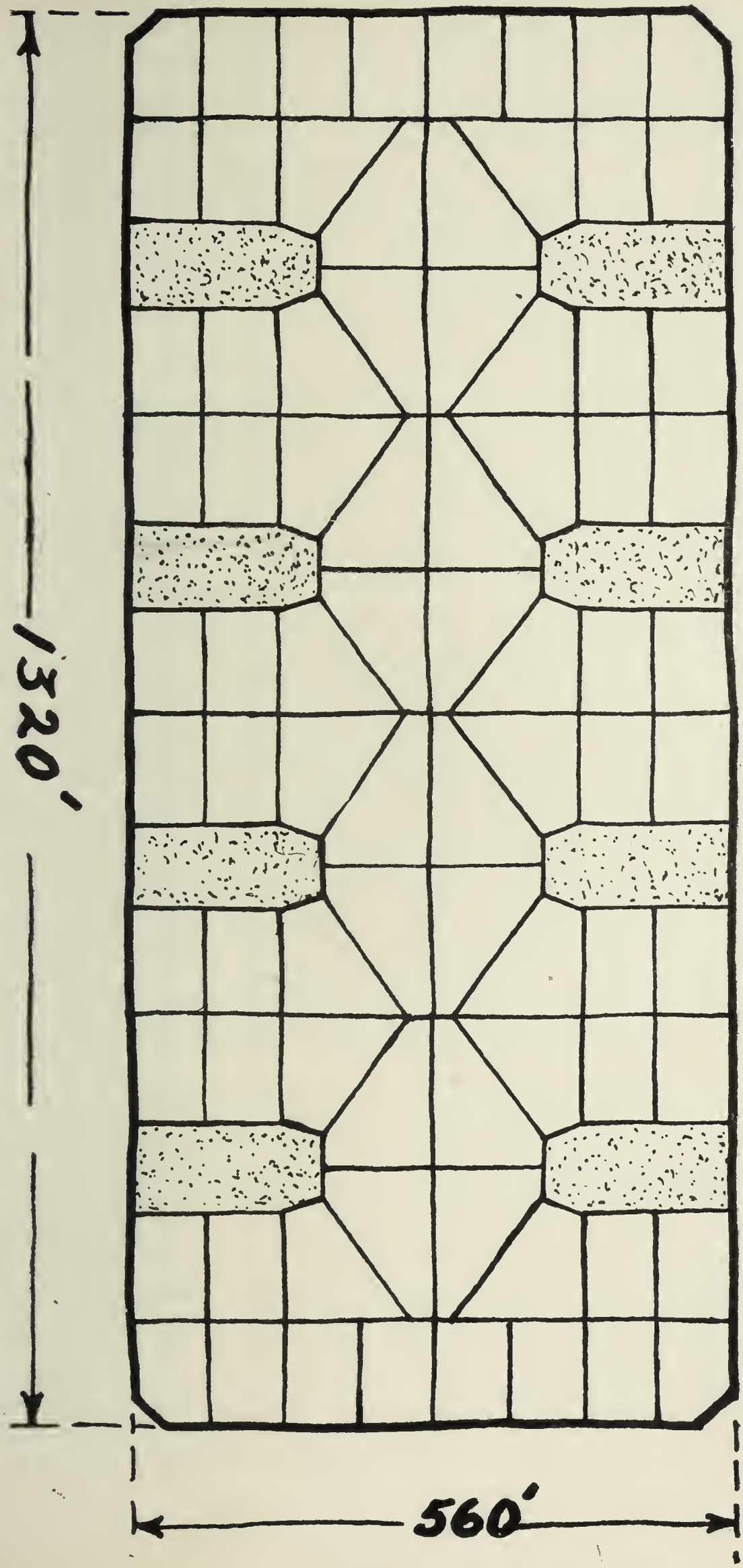


Fig. 32
ROAD BAY BLOCK

higher land cost Layout No. 3 will appear still worse in comparison with the others. The results of Table E read together with those of Table D point to study layout No. 5 as being the most economical.

For the various services and development costs the various studies work out as follows :—

Lowest No. 1—highest No. 3.

Lowest in road cost No. 5—highest No. 6.

Lowest in sewer cost No. 2—highest No. 6.

Lowest in S.W. Drainage cost No. 5—highest No. 3.

Lowest in water reticulation cost No. 6—highest No. 2.

Lowest in electrical reticulation No. 6—highest No. 3.

Expenditure or costs must not alone be considered for an important factor is the return received. Table F therefore gives the total expenditure per erf or land and service as well as the total return based on the value of £200 per erf. It also gives the surplus per erf and total surplus as well as the index of comparison. From these it will be seen that study layouts Nos. 5 and 1 have the highest index figure and are the most economical.

A factor that must be taken into consideration is the speed with which erven in a township sell. An attractive layout will sell quicker than one that is not so. Taking this into consideration. Study layout No. 5 will be the most economical of all the study designs.

The study further revealed that the U-loop with built up ends can only compete with the long blocks as in study layout No. 1 if the U-loops are over 500ft. deep. If they exceed 700—800 feet they become far too inconvenient. The open end U-loop, used in study layout No. 4 can never compete with the long block in low road percentage. If the ends of the loop in this type of layout are connected, the increase in cost amounts to £1,389 on Layout No. 5. In such cases, however, the loops may be increased to over 800ft. deep and this will largely neutralise the additional cost of connecting up of the ends. The layout will then, however, cease to be one of U-loops and may rather be regarded as one of precincts.

Deep Road Bays.—This method of layout results in large blocks, too rigid to use to such an extent as to compare in this way with the study layouts Nos. 1 to 6. It may, however, be studied by comparing it with long rectangular blocks and an approximate result may be obtained.

If the 70 × 100ft. erf is used and road bays of 180ft. depth on two sides of the block are adopted, it will result in a block size of 1,320 × 560ft. and 80 erven (see Figure 32). This gives a road length of 1,930ft. or 24·1ft. per erf. Where the road access must be given to garages in the bays the road length will be 3,530ft. or 44·1ft. per erf. A rectangular 140ft. depth block of 1,330ft. long will give 38 erven and a road length of 1,570ft. or 41·3ft. per erf.

Road bays are likely to cost less for sewerage and stormwater drainage but more for water and light reticulation. The footpath costs will also be greater.

Summing up it may be said that road bays where no road access to garages need be supplied, such as in locations, will prove more economical than the study layouts but where road access to the bays must be provided they will prove more expensive than the ordinary long block. A certain amount of loss of land occurs with the creation of numerous small open spaces in the bays and where land prices are high this will have an important bearing on cost and may make road bays uneconomical.

TABLE D.

Stdy.	No. of Erven	Roads			Area for Schools and Parks		Area Devoted to Erven	
		Length in Ft.	Area in Acres	Per cent	Area	Per cent	Area	Per cent
1	677	34,215	51·9	28·1	18·1	9·8	114·7	62·10
2	675	33,515	51·6	27·94	18·5	10·01	114·6	62·05
3	637	30,255	49·25	26·66	18·0	9·75	117·45	63·59
4	639	31,995	50·25	27·21	23	12·45	111·45	60·34
5	650	30,175	49·32	26·63	21·75	11·79	113·63	61·58
6	673	34,765	53·66	29·05	18·04	9·77	113·0	61·18

Note.—Total area of layouts 184·7 acres. 7 acres provided for school.

TABLE E.

Development Costs per Erf.*

	1	2	3	4	5	6
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Land†	27 6 0	27 6 7	29 0 3	28 18 5	28 8 7	27 8 11
Roads	92 15 0	92 10 0	93 10 0	95 10 0	91 15 0	96 10 0
Sewers	16 13 6	15 16 1	17 7 2	17 0 10	16 1 7	19 6 7
Stormwater .. Drainage	16 2 3	17 19 1	17 19 3	15 4 2	15 2 1	15 6 11
Water Reticulation ..	8 14 8	9 11 7	8 18 0	8 16 0	8 19 0	8 8 0
Electricity Reticulation ..	7 5 2	7 16 4	7 18 4	7 0 4	7 4 4	6 16 10
	£168 16 7	£170 19 8	£174 13 0	£172 9 9	£167 10 7	£173 17 3

* For details of costs see Appendix.

† Price of undeveloped land taken as £100 per acre.

TABLE F.

Total Expenditure and Return.

	1	2	3	4	5	6
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
A—Total Expenditure per erf	168 16 7	170 19 8	174 13 0	172 9 9	167 10 7	173 17 3
B—Return per erf at £200..	200 0 0	200 0 0	200 0 0	200 0 0	200 0 0	200 0 0
Surplus per erf ..	31 0 0	29 0 4	25 7 0	27 10 3	32 9 5	26 2 9
Total Surplus on layout	21,102 13 1	19,586 5 0	16,147 19 0	17,580 9 9	21,106 0 10	17,590 10 9
Index of comparison — $\frac{B}{A}$	1·19	1·17	1·14	1·16	1·2	1·15

*Chapter V**

SUBDIVISION OF BLOCKS INTO ERVEN

The shapes of erven obtained when a block of land in a township is subdivided depends to a great extent on the shape of the block. If difficulties are therefore to be avoided in the subdivision care must be taken to first design reasonably shaped blocks. Figure 33 shows examples of bad block design which results in difficult erven and waste of land in superfluous roads. The solutions to these problems are shown and the road saving is obvious. There is also a gain in the number of erven.

Erven are essential as land units for the erection of buildings. It seems superfluous to make this statement but, if existing townships are studied, it is obvious that the site planner in many cases, has almost or entirely overlooked this primary purpose of erven. In many layouts, ease of calculation, plotting and pegging out appear to have been the dominating or sole consideration.

It is certainly not always possible to have ideally shaped erven. Odd shaped blocks are sometimes unavoidable, owing to the boundaries of land, topographical features, main roads and railways. It is these odd-shaped blocks which must have particular consideration when dividing them into erven if badly designed erven are to be avoided.

Industrial layouts are primarily based on the location of the railway sidings. It is usual to make the blocks in them fairly large and regular in shape. Siding and road frontage should be carefully economised, and provision made for the loading and unloading of vehicles in such a manner that through traffic is not interfered with.

Business erven for offices and shops are best made rectangular in shape. For suburban or local shopping centres they should be small, 60×120ft. deep to 70×150ft. deep being suitable sizes for such erven. Large erven play into the hands of monopoly interests that may prevent shops needed by the inhabitants being erected or alternatively may prevent competition.

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* Matter in this Chapter taken largely from "Remarks on the subdivision of of Building Blocks into Erven" by T. B. Floyd. Proceeeings South African Society of Civil Engineers, Vol. XXXVI, 1938.

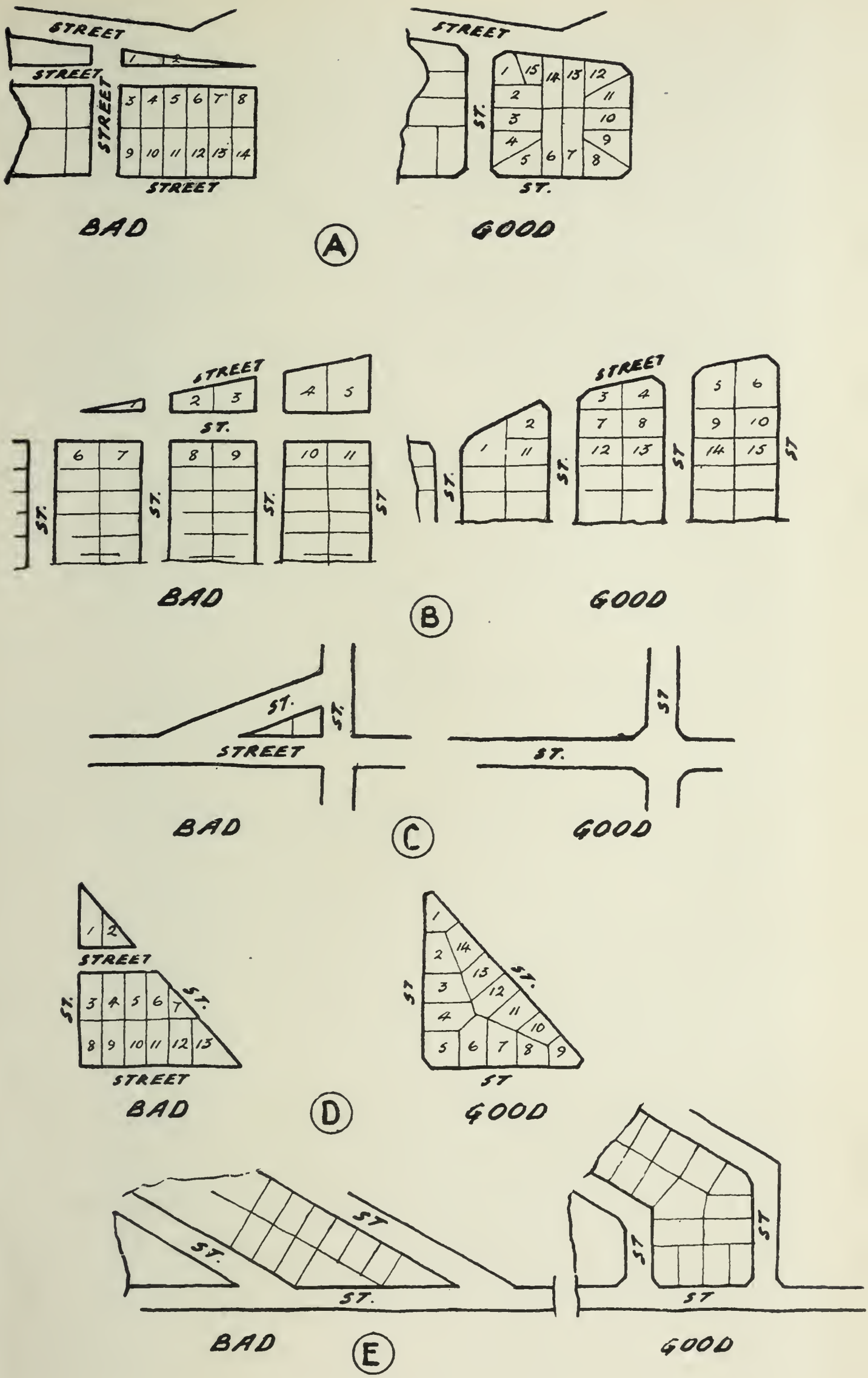

Fig. 33

EXAMPLES OF BAD BLOCK DESIGN TAKEN FROM EXISTING TOWNSHIPS AND GOOD SOLUTIONS OF THE PROBLEM

Residential erven may vary greatly in size and shape, but generally the smaller they are the more important it is that they should approach to the rectangular shape. From 60 × 120ft. to 70 × 120ft. are good sizes for small houses but the average house of good type requires a site of 70 × 150ft. or 80 × 150ft. at least.

For the working man a depth of 120ft. has great advantages over the common 100ft. depth for it gives more yard space for small children to play in. A width of 60ft. is about the minimum to allow for a house with a garage but it then gives little side space. Widths over 70ft. increase the size of the front garden too much and therefore the cost of keeping it in order for the working man. Greater widths also of course increase the cost of services and road making beyond what is economically sound in comparison with the rates derived from the smaller type of house.

Erven may without disadvantage be irregular in shape if not small and provided the shape is such that the dwelling and outbuildings may easily and comfortably be arranged.

Erven for special sites should be planned to meet the particular needs of the use of such sites.

The sites provided for hotels should be ½ morgen in size if in town centres and 1 morgen at least when in suburban areas.

Suburban flats and other general residential buildings need a site of ½ morgen or more to allow space for children to play and for tennis courts as well as for a garden.

Not less than ¼ morgen is suitable for a public garage site and ⅛ morgen for that of a bioscope.

Institutions such as nursing homes require a site similar in size to that for blocks of flats.

It is easier to know what to avoid, if what is required is clear in one's mind. The main considerations are :—

i. *The Type and Size of Buildings Likely to be Erected.*—Upon this depends the shape and size of the erven.

ii. *The Position of and Space About Buildings.*—It is often advantageous to be able to build square to the front boundary of the erf. As far as dwelling houses are concerned, these would have sufficient free space in front, at the sides, and in the rear. The front space is to provide for a garden, which ought not to be too large for the income of the occupier, and yet should be sufficient to keep the house back from the road. The front garden should be of such a shape as to enable a suitable layout to be made. The side space is valuable in separating the dwelling from the adjoining ones, giving privacy and providing for light. At the rear the space is useful in separating the Native servants' quarters, with their noise, from the main building. It also provides play space for small children and spaces dwellings apart at the rear thus ensuring a measure of privacy.

iii. *Topography of Site.*—On steeply sloping and broken ground, the contours often force the adoption of shallow erven or erven with wide frontages.

iv. *The Probable and Possible Placing of Outbuildings.*—These must never be in front of or close to dwellings nor so situated as to be in full view of the dwellings across the road. The erven should be so designed that this is always avoidable.

v. *Acute Angles.*—These create areas difficult to use and are therefore to be avoided wherever possible. They are particularly bad at the rear of erven.

vi. *The Splaying of Outside Corners.*—Erven on corners should be so shaped that the dwelling may be erected square to the splay.

vii. *Building Lines.*—On main roads it is often the practice to fix 40ft. to 50ft. building lines.

Figure 34 shows numbers of badly designed erven in existing townships both of old and more recent design. The probable positions that dwellings and outbuildings would occupy on such erven are also shown. The triangular and irregular blocks shown are subdivided in a number of different ways and all of them are bad.

In blocks shown in all the figures except H, J and T the outbuildings will be so placed as to be in full view of the dwelling across the street. In many cases erven are double fronted with the backs exposed and spoiling the outlook of other dwellings opposite these backs.

Figure 34, A to G, K to N, Q and R all show blocks in which the outbuildings of some of the erven will be so sited as to be in front of the dwellings of adjoining erven or placed so as to be a nuisance to such dwellings.

Many of the blocks as in Figure 34 have triangular erven, mostly with sharp angles at the rear which could have been avoided by proper design.

Figure 35 A to V show the same blocks properly subdivided to avoid the mistakes and bad features of the examples in Figure 34 A to V. Additional examples of blocks having shapes not given in the bad examples are also illustrated.

A further study of these figures will show that no outbuildings need in any case be erected to be in a position which will be a nuisance to any dwelling adjoining or across the road. Not even in the small triangular blocks does any fault occur.

The subdivision of blocks into erven is important because it creates the sites for buildings. Care should be taken and proper thought given when subdividing blocks. Some blocks may allow of more than one good way of subdividing them but there is no other satisfactory way of treating triangular blocks except that shown in the good examples given in Figure 35.

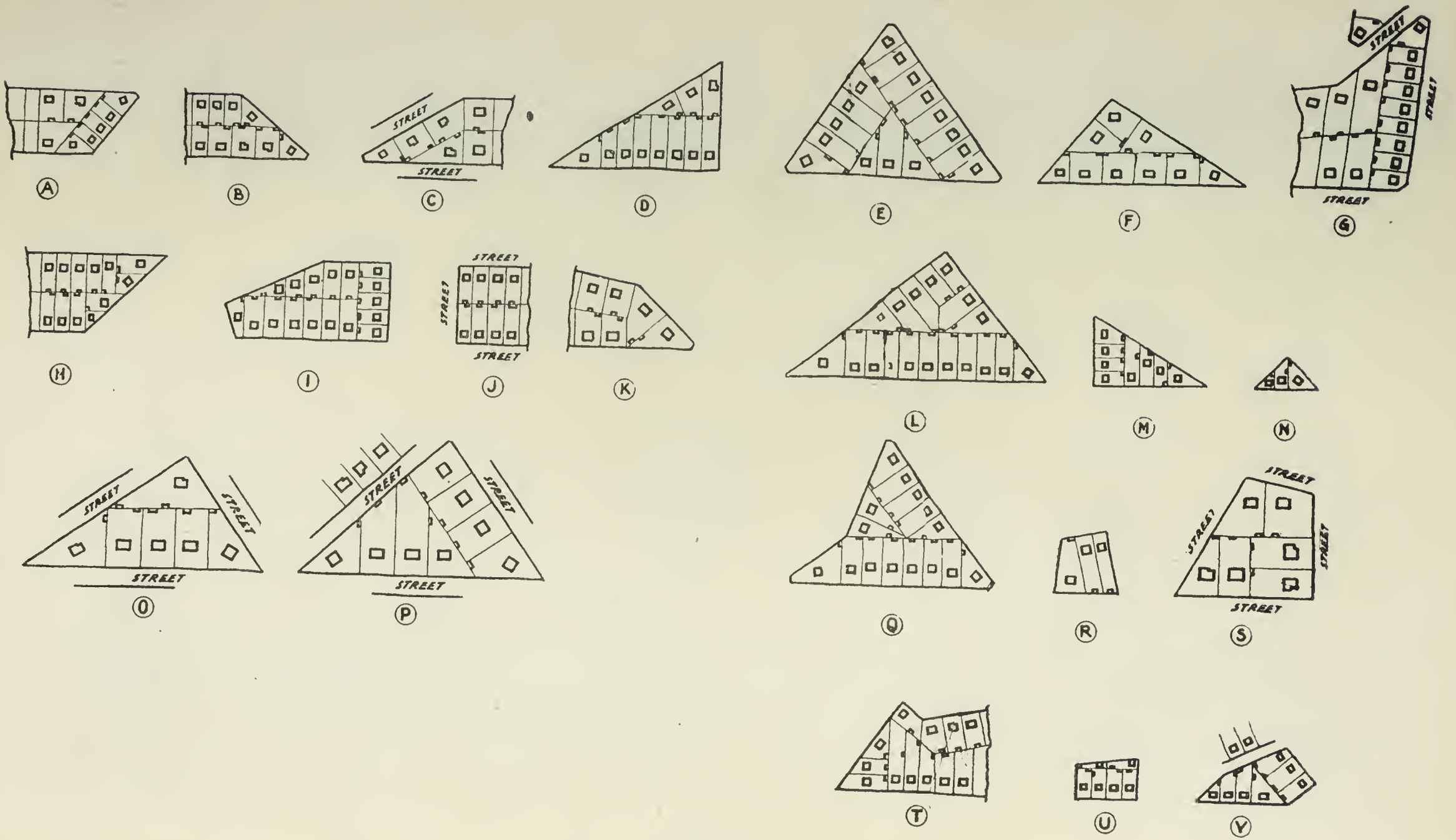

Fig. 34

EXAMPLES OF BAD SUB-DIVISION OF BLOCKS INTO ERVEN

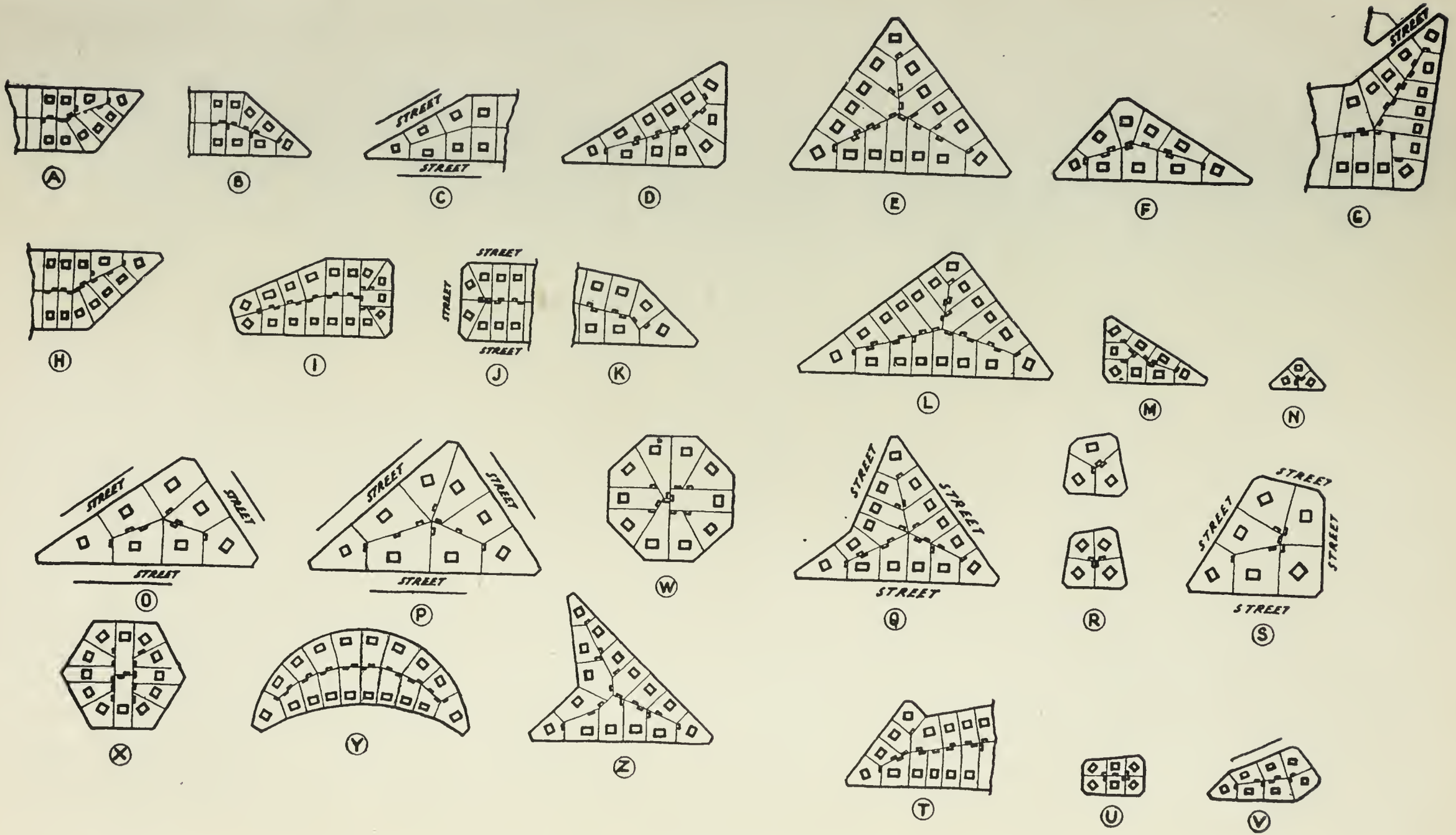

Fig. 35

EXAMPLES OF WELL DESIGNED SUB-DIVISION OF BLOCKS INTO ERVEN

Chapter VI

ENGINEERING AND TRAFFIC IN RELATION TO TOWNSHIP DESIGN

1. Generally
2. Roads
3. Sewers and Drains
4. Water Mains and Electricity Reticulation
5. Intersections and Junctions

1. GENERALLY

When farm land is converted into township the principle work involved may be divided into the following :—

(*a*) Survey and Design,
(*b*) Erection of Buildings,
(*c*) Engineering Work and
(*d*) Landscape Work.

(*a*) The survey and design work costs only a fraction of the total cost of development and little can be saved on this work. In spite of this survey, difficulties should not be unduly multiplied and the cost thereby increased.

(*b*) Building work accounts for the greatest expenditure in cost but it is split up into small units each complete in itself and designed, constructed and paid for by a large number of different persons.

Only when ground is very broken will the design of a township affect to any great extent the costs of these units. It may, if bad, force buildings on to ground where costs are increased, e.g. steep slopes, filled-in ground, low lying land or rocky outcrops.

(*c*) The engineering work may only amount to second place in regard to cost units making up the total development cost of a township but it is the most affected by the design of the layout. Roadwork, stormwater drainage; sewerage, water reticulation and electricity reticulation are all vitally affected as to cost by the design. It is on these services particularly that bad design will result in great increases of cost and waste of money.

(*d*) The landscape work is also affected by design but the cost to that of the whole is proportionately small.

Consideration should be given to it in the design but in due proportion to its importance.

2. ROADS

A layout design does not only affect the cost of roadwork because of length and area but also because of the cross-section which results therefrom.

Apart from cost, bad design may create engineering difficulties which cannot be rectified even by increased cost. Examples of this are found in many old townships, where roads are planned directly at right angles across the contours of land so steep that any roads made would be useless to vehicular traffic.

Another difficult problem created is that resulting from the design of roads in such a manner that high banks and deep cuts are forced where frontages of erven occur. Such banks and cuts make access to the erven affected extremely difficult and may in some instances make it impossible.

It has been said by some architects that civil engineers make too much of the road framework in township design. This is of course not so. The whole reason of township design is to provide building sites and access to them. These two are so bound together that the one is useless without the other.

Whether the access to sites is good depends entirely on the road framework. Obviously then no good layout is possible unless full thought and attention is given to the road framework.

Grades

The grades to aim at in townships largely depend on the natural slope of the site. Standards laid down for grades are like many other standards in township design, *i.e.* they should be worked to where possible but may, under special circumstances, be departed from to some extent.

On gently sloping sites it may be quite easy to achieve ideal grades but on steep sites much steeper grades must be used and good planning should result in no grades being steeper than 1 in 15 on main roads and 1 in 12 on local ones. There are, however, cases where a 1 in 10 grade is good and where short lengths of 1 in 8 are permissible. When determining grades of roads from contours allowance must always be made for the unavoidable inaccuracies of same. After all, 5ft. contours cannot give the same results as levels along the road route. A grade of 1 in 10 from contours may easily turn out to be 1 in 8 when actual levels are taken.

It is only steep grades that affect traffic and the steepness allowable is determined by traffic convenience. Roads which carry little traffic may be made steeper than those carrying heavy traffic. The flatness of grades has no effect on traffic but may seriously

affect sewers and stormwater drains. Sewers and stormwater drains are not affected by the steepness of roads for before a grade is reached that would affect them a halt is called by traffic requirements.

Traffic therefore determines the maximum steepness whilst drainage determines the maximum flatness of grades.

To facilitate and make sewerage easy a grade of 1 in 100 is ideal but up to 1 in 200 will seldom cause much trouble.

For stormwater surface channels a grade of 1 in 200 is ideal whilst less than 1 in 400 should be avoided or difficulties will arise.

Summing up then it may be said that ideal road grades lie between 1 in 50 and 1 in 100 whilst a road should not exceed a minimum grade of 1 in 400 or a maximum of 1 in 12 for local roads and 1 in 15 for main roads. An exception is where such grades are impossible or where the distance is very short, but then in such a case it must be fully realised that difficulties will arise and solutions must be found for these difficulties beforehand.

Crossfall of Road Sites

The crossfall on a road route will affect costs and difficulties of road construction if it is large, and careful study must therefore be made of the crossfall.

Any banking of roads will throw buildings on the lower side in to a hole and make access to the road from such buildings very difficult. Except where erven are very large, banking can rarely be resorted to in township roads. The proper cross-section of the road must therefore be normally obtained by cut on the upper side.

Figure 36 illustrates the effect of slopes on road cross-sections and shows the cuts required on various slopes. Extra width must be allowed for roads on sites with steep crossfalls where such roads are planned along the contours. Where the crossfall does not exceed 1 in 15 the effect can easily be taken in the road and footpaths or centre islands, but it is when the crossfalls exceed this that extra width must be allowed for cut.

On main roads it may be found economical to split roads into dual carriageways at different levels where crossfalls are more than 1 in 15 (see Figure 36 F). The shaded portion illustrates the excavation saved by splitting the road as suggested on a ground surface grade of 1 in 4.

Although excavation is saved by this method kerbing and road surface may be considerably increased and their cost must be balanced against that of excavation before a decision as to method of construction is arrived at.

Because of the excavation involved it will be realised how important it is on steep and rough sites to carefully select the road routes. A movement of 100ft. will often save considerable excavation.

Valleys and tops of ridges should be taken advantage of as much as possible to site roads along except of course where they are very steep and rugged or where large quantities of water must be dealt with in the valleys.

Figure 36 G illustrates roads located on ridge and in valley. It is seen that with such road sites no crossfall results and therefore no cutting for cross-section is required. If in Figure 36 G the road is moved from the position shown in 1 and 3 to that in 2 a crossfall of 5—7ft. would result within the road reserve and considerable excavation becomes necessary.

Only in cases where the route over the ridge would result in too steep a grade on portions should the location along the slope be selected.

Located on a ridge a road will only be affected by the small amount of stormwater falling on its own surface whereas a road in a valley must cope with considerable stormwater flowing into the valley. The dual carriageway road with a centre island is a good type to use in valleys for then the stormwater may be taken down the centre island.

Steep valleys call for a road on either side with a park strip along the bottom of the valley.

Widths of Road Reserves

Road reserve widths depend on the traffic they are likely to be called upon to carry except in special cases where an ornamental effect is aimed at.

If road widths are wider than need be the result is a waste of land and unnecessary cost of construction and maintenance. There are however minima below which road reserve widths cannot be satisfactory.

In the majority of the provinces it is now usual to regard 40 Cape feet as the minimum for a road or street reserve width.

In determining the width of the road reserve in townships the width of the carriageway must be determined by traffic requirements and the footpaths by the requirements of the pedestrians and services. Traffic lanes should be 11ft. for moving traffic and 9ft. for parked vehicles on all except main roads where traffic exceeds 200 vehicles per hour and speeds are over 35 miles per hour. For main roads the traffic lanes to adopt are 12ft. for moving traffic and 10ft. for parked vehicles. No parking should be permitted on main roads during peak hour traffic flows. The parking lane then becomes a slow traffic lane. It is good in addition to allow a foot at each kerb for gutters and thus increase the effective width of the parking lanes. The great majority of roads in a township are residential ones where the parked vehicles are spread far apart in such a manner that moving traffic may use the lanes to a large extent.

The minimum suitable width of a footpath without trees may be taken as 6ft. and with trees 10ft. On important roads where many cables are possibly required a width of 12ft. will be necessary and if the trees are set back 6ft. from the kerb instead of 3ft.—a better arrangement—a width of 15ft. will be essential. Where cycle tracks are required a minimum width of 15ft. becomes necessary.

Using these standards to build up the required road reserves, the minimum carriageway for short unimportant roads such as culs-de-sac or short cross roads will be 20ft. and if to this the minimum footpaths of 6ft. are added an absolute desirable minimum for a road reserve is 32ft. This does not provide for trees and where these are required the minimum must be 40ft.

Where there is any likelihood of even a small amount of through traffic and the road is over say 400ft. long the minimum reserve should be 51ft. even for a residential road. Such a width allows three traffic lanes, one of 11ft. and two of 9ft. as well as 10ft. footpaths.

Figures 37 and 38 illustrate cross-sections showing various recommended road reserves. All of these are built up on the standards already mentioned and allow no waste.

The 51ft. reserve which allows three traffic lanes, *i.e.* one moving and two parking, in practice provides two moving traffic lanes, because the parking lanes are not fully used for parking.

The reserves suggested must be regarded as minimum widths to which any increased width for special reasons should be added. The measurements used are English feet but the suggested Cape feet approximate equivalents are shown. The few inches difference, more or less, in the suggested conversion may be taken up in the centre islands or footpaths.

To the widths illustrated must be added that needed for cuts where considerable side slopes occur as already mentioned in the subsection of this chapter dealing with crossfall.

With regard to positions for lamp poles, electric poles and telephone poles, it is usual for lamps and electric poles to be on one side and telephone poles on the opposite side of single carriageway roads. On wide double carriageway roads lamp poles may be placed in the centre islands and on both footpaths in which case telephone poles will be placed near the boundary lines and encroaching on the cable space.

In industrial areas and the business centres of towns the minimum reserve width desirable is the type with a four lane carriageway. Dual carriageway roads are not suitable in industrial townships because of the heavy lorries and trailers which must manoeuvre in such areas. Footpaths in these areas must be at least 12ft. wide which means that the minimum road reserve should be 65 Cape feet. Under certain circumstances wider footpaths may be needed and so may cycle tracks and in such cases the reserve widths should be increased. Where traffic is at all heavy, roads in industrial areas should be type J but 12ft. lanes should be used and therefore a reserve width of 70 Cape feet.

All main through roads should be designed as dual carriageway roads with a minimum width reserve of 80 Cape feet.

There is no reason why a road passing through a town should have the same reserve width for the whole of its length. It is far more correct to decrease the width from the centre of a town outwards towards the outskirts for this is in accordance with traffic flow.

TABLE G.

Suggested Minimum Street Reserve Widths in Townships.

Class of Road	Width in Cape Feet			
	Cross Falls of Land			
	up to 1 in 15	1 in 10	1 in 6	1 in 4
Short Culs-de-sac (without trees)	32 Type E	35	40	50
Short Culs-de-sac (with allowance for trees)	40 Type F	45	50	60
Residential Streets (through traffic but length less than 400′)	45 Type G	50	55	65
Residential Streets (through traffic negligible)	45 Type G	50	60	65
Residential Streets (over 400′ and with proportion of through traffic—average street)	50 Type H	55	65	70
Feeder Streets to Residential Areas	65 Type J	70	80	90
Streets in Business Areas (not main through roads)	65 Type J	70	—	—
Streets in Industrial Areas (not main through roads)	70 and 80 Type J modified	—	—	—
Main through Roads, Dual Carriage-way Streets (parking provided)	80, 90 & 120 Types K, L and M	90, 100 & 130	100, 110 & 140	110, 120 & 150
Main Arterial Roads (no parking provided)	120 Types P and Q	130	140	150

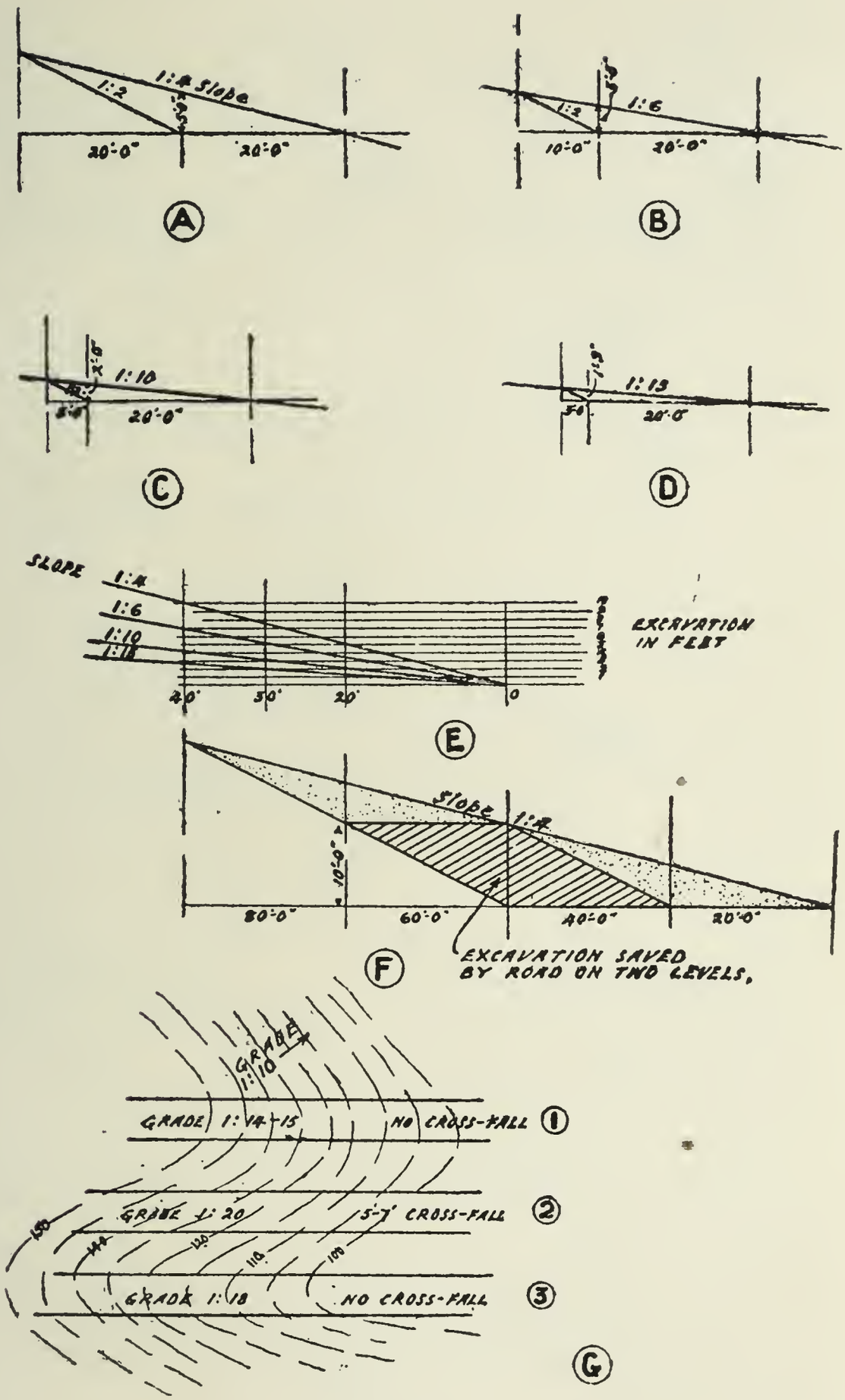

Fig. 36

SHOWING AFFECT ON ROADS OF CROSS-FALL OF LAND

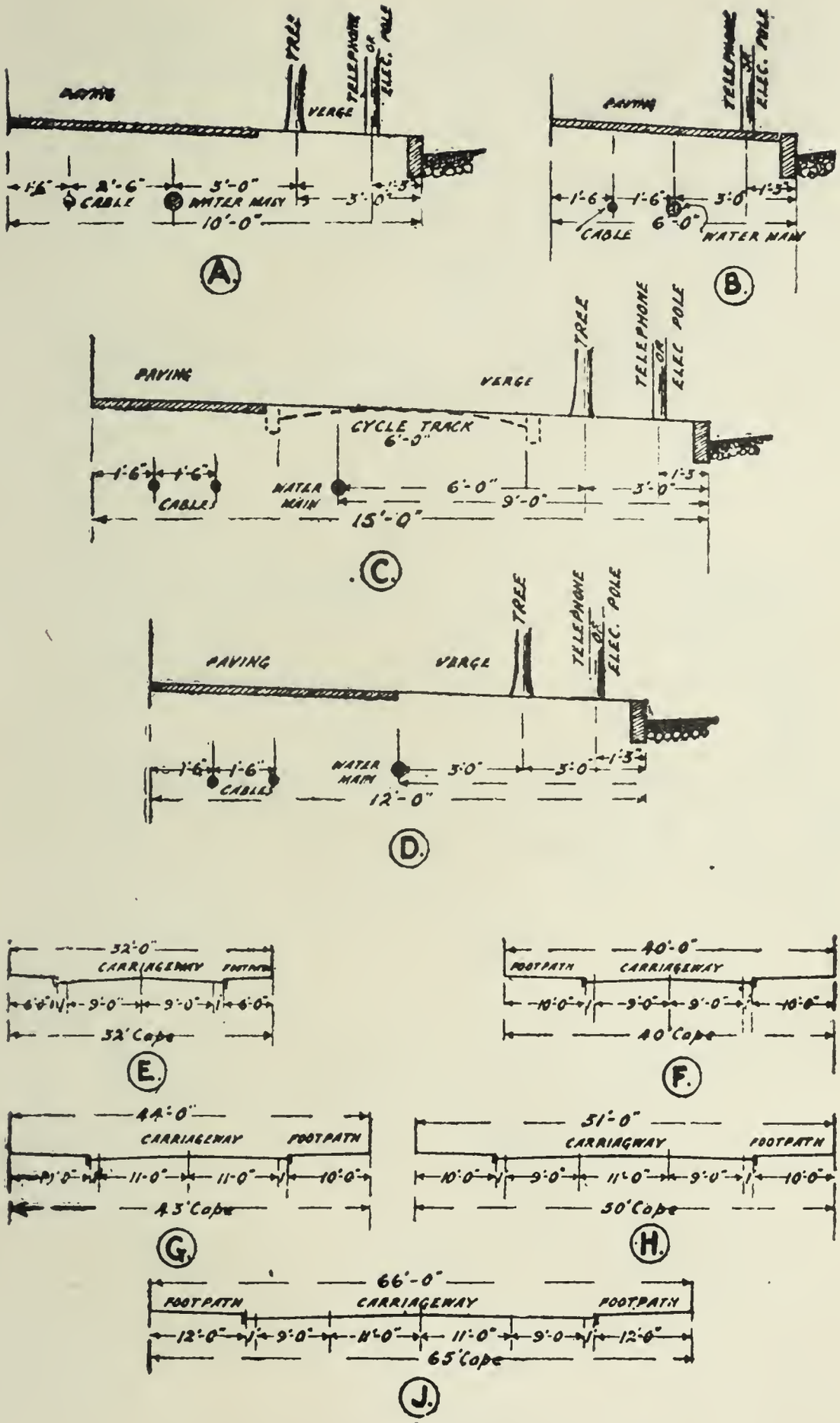

Fig. 37

CROSS-SECTIONS OF FOOTPATH TYPES FOR URBAN STREETS AND CROSS-SECTIONS OF LOCAL AND SECONDARY ROADS

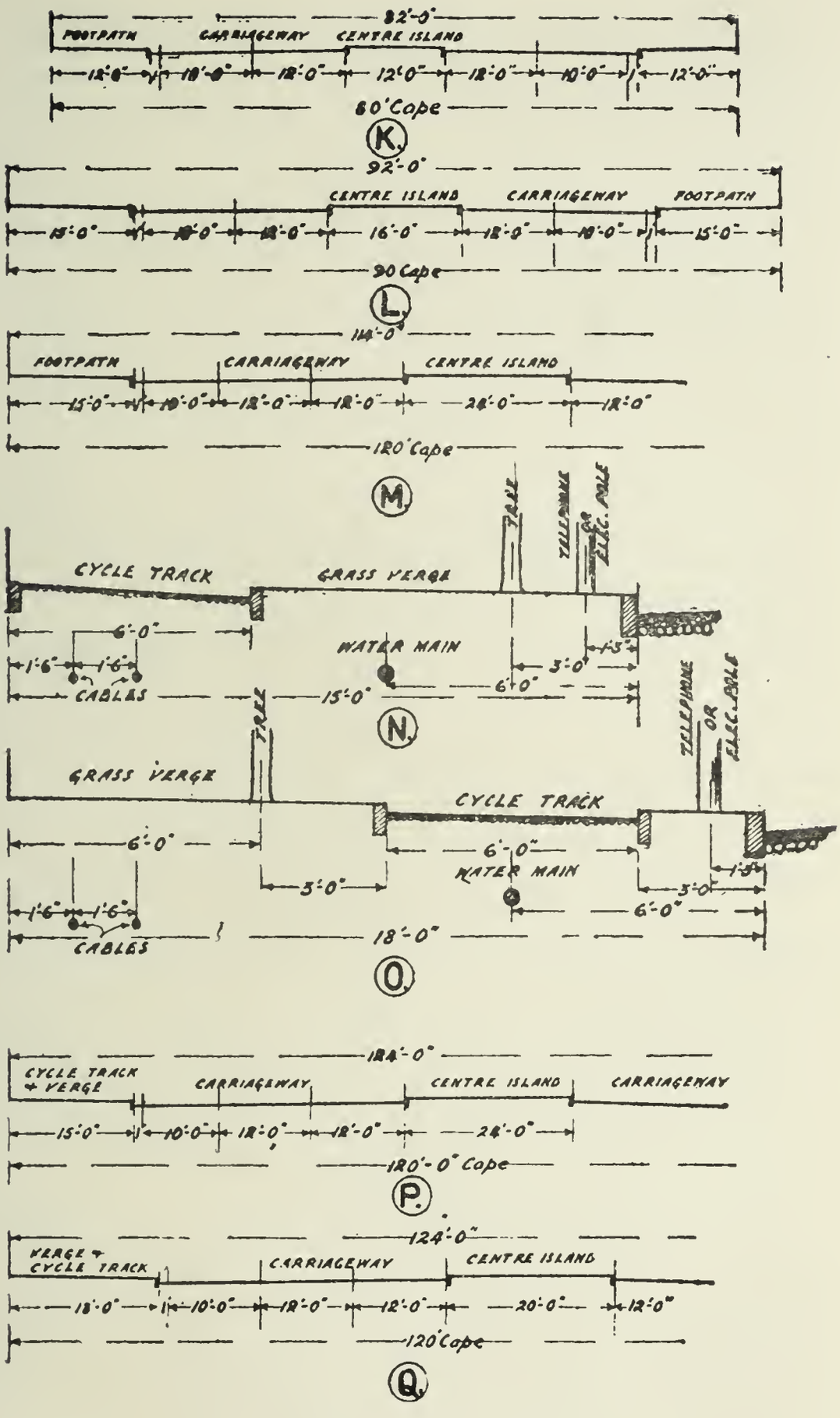

Fig. 38

CROSS-SECTIONS OF SIDE SPACES FOR MAIN ROADS AND STREETS AND CROSS-SECTIONS OF MAIN STREETS

This of course does not apply to inter-town main roads but to internal main roads.

All main roads and main feeders to residential areas should have at least four traffic lanes.

Certain important arterial roads should have no direct frontage on to them and would therefore need no footpaths. Figure 38, types P and Q are the correct cross-sections for these roads but the verges should have cycle tracks and not footpaths in them. The layout of the verges for these arterial roads is shown in Figure 38, N and O. No parking lanes are required but lanes for slow traffic are necessary. Roads in small holdings should not be less than 50 Cape feet wide. They are usually developed as country roads, *i.e.* without footpaths and underground drainage and for this reason need space for sluits or open drains. Grass verges along which to drive cattle are also needed.

Table G.

3. SEWERS AND DRAINS

Effect of Grades on Sewers and Drains

The flow of water and liquid in sewers and drains is due to gravity only. This flow is affected by friction, bends and obstructions which retard the flow. Velocity or the speed with which liquid flows in a pipe or channel is due to gravity of a freely falling body as expressed by the formula :—

$$V = \sqrt{2gh}$$

where V = velocity in feet per sec.
h = head
g = acceleration (32·16ft. per sec.)

From the contact between the liquid and the surface of a pipe or channel friction arises.

This varies with the roughness of the surface of the pipe or channel and also with the velocity of the liquid flowing in such pipe or channel. The proportion then between the cross-sectional area of the pipe and the wetted perimeter is an important condition affecting the velocity of flow in sewers and drains.

Velocity is increased by increasing the proportion of the cross-sectional area of the liquid in relation to the wetted perimeter.

The ratio between these or $\frac{\text{area of cross-section}}{\text{wetted perimeter}}$ is called the " hydraulic mean depth " or " hydraulic radius " and letter R is used to denote this. (see Figure 39.)

It will be seen that R will increase as the pipe flows with more depth of liquid for the cross-sectional area increases more rapidly than the wetted perimeter. This goes on until a pipe flows ·8 of full depth. After this with further increase of flow the wetted

perimeter increases proportionately more rapidly as will be seen by studying Figure 39 C until when flowing full the wetted perimeter is double that when flowing half-full and so is the cross-sectional area. In other words then R has the same value for a pipe flowing half-full and one flowing full.

From these considerations the early formulae for velocities were derived. A well known one being that of Chezy.

$$V = C\sqrt{RS}$$

where V = Velocity
C = An empirical constant
S = Sine of slope or $\frac{\text{height}}{\text{length}} = \frac{h}{l}$
h = Height or fall
l = Length of pipe

This formula gave approximate results but was rather inaccurate for certain sizes of pipes.

Velocity does not really vary with the $\sqrt{}$ (square root) of R and S but does so approximately only. However, this formula remained the basis of all others.

The first efforts to improve the accuracy of velocity formulae concentrated on obtaining more accurate values for the constant C.

Kutter's formula to give the value of C is one of the best known and it takes the roughness of the pipe surface into account.

(*Kutter*)
$$C = \frac{41{\cdot}6 + \frac{{\cdot}0028}{S} + \frac{1{\cdot}81}{n}}{1 + \frac{(41{\cdot}6 + \frac{{\cdot}0028}{S})\, n}{\sqrt{R}}}$$

The values of n are approximately :—

Neat cement, glazed pipes and smooth iron pipes	·010
Smooth concrete or iron pipes	·011
Ordinary iron pipes	·012
Smooth brickwork, concrete or pipe sewers ..	·013
Ordinary brickwork	·015
Rubble or granite blocks paving	·017

·013 as value for n is usually taken for sewers and drains.

More recent velocity formulae are similar to that of Williams and Hazen. This is as follows :—

$$V = CR^{0{\cdot}63}S^{0{\cdot}54}$$

The discharge of pipes is arrived at by multiplying the cross-sectional area of the stream by the velocity or

$$Q = Va$$

where Q = the discharge in cubic feet per sec.
V = the velocity in feet per sec.
a = the cross-sectional area in sq. ft.

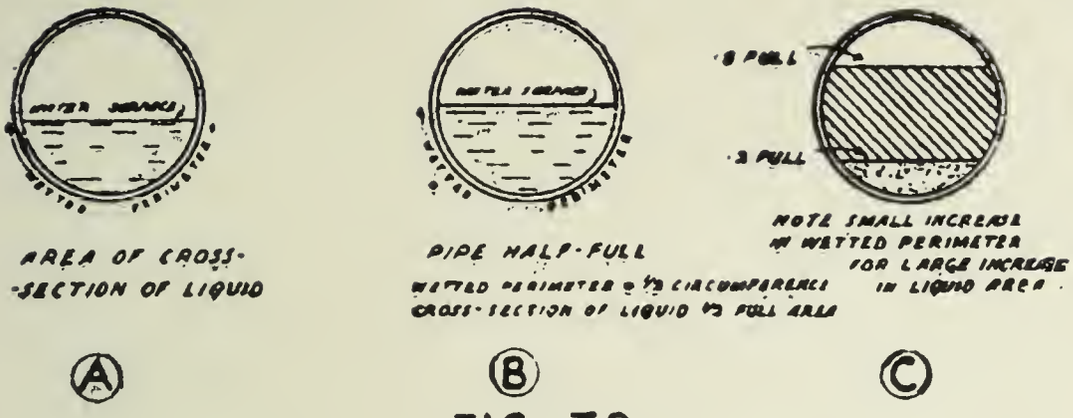
AREA OF CROSS-SECTION OF LIQUID
PIPE HALF-FULL
WETTED PERIMETER = ½ CIRCUMFERENCE
CROSS-SECTION OF LIQUID ½ FULL AREA
NOTE SMALL INCREASE IN WETTED PERIMETER FOR LARGE INCREASE IN LIQUID AREA
A
B
C

FIG. 39

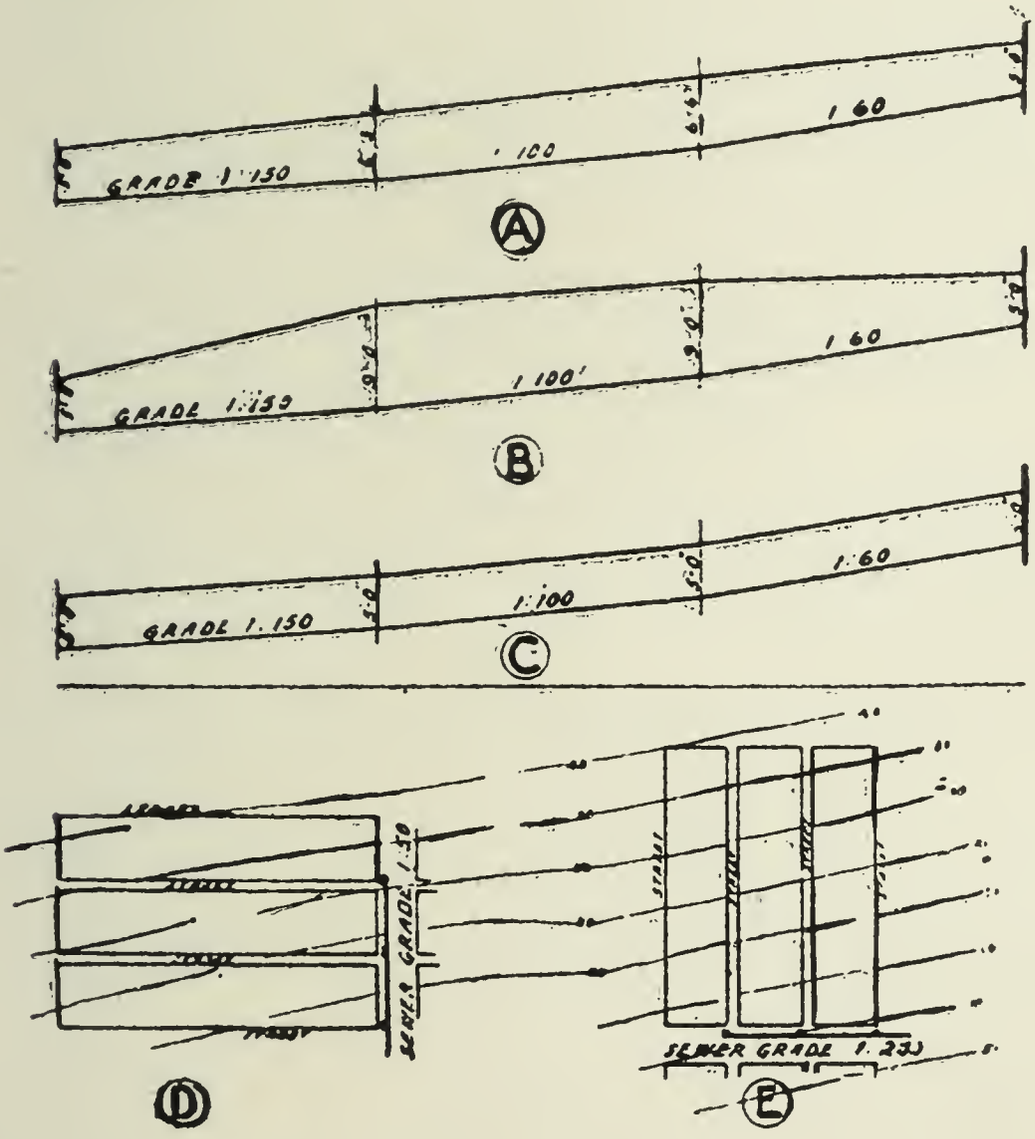

Fig. 40

EFFECT OF STREET GRADIENT ON SEWERS

The capacity of a sewer is the discharge and this determines the size of pipe required.

It is usual to consider the general maximum flow in a sewer to be twice the average flow over twenty-four hours. The general minimum is usually taken as half the general average in main sewers and one-third in branch sewers. At the heads of sewers the flow is eratic and the general minimum should be taken as one-quarter the general average.

The general average flow in a sewer should give a velocity of 1½ft. per second which is sufficient to prevent any deposits from domestic sewage and is sufficient to move gravel. The general minimum flow should give a velocity of 1ft. per second and the general maximum will then be about 2ft. per second. This means that at the general minimum flow no deposit of sewage or fine silt will occur, but the general maximum happening daily will flush the sewer and remove even small stones. The velocities given are good conservative figures to work on. Some engineers have in practice used lower velocity figures with success.

Sewers should therefore be designed to give a velocity of 2ft. per second when flowing half-full unless the flow is such as to be 75% of the maximum discharge when the general maximum flow takes place in which cases the velocity may be less when half-full. Note that 75% of the maximum discharge is the limiting working capacity of any sewer. Sewers are never designed to flow full for then they would be under pressure.

Stormwater drains must deal with more silt, leaves, debris and such matter than sewers and they should therefore be designed to have a velocity of 5ft. per second for the usual storm.

When flowing half-full it requires a grade of 1 in 150 for a 6″ pipe and 1 in 250 for a 8″ pipe to give a velocity of 2ft. per second. Most branch sewers in streets will be either 6″ or 8″. It is well to think in terms of 6″ sewers when considering residential streets or roads and their grades.

A grade of 1 in 200 will give 3ft. per second velocity in a 12″ pipe running half-full and this is the smallest size pipe recommended for stormwater drains.

The ideal flattest grades to suit side gutters, stormwater drains and sewers is 1 in 150 to 250. Flatter grades in streets will increase excavation for sewers. A grade of 1 in 300 for example will increase the depth of a 6″ sewer by 4ft. on a street block of 1,200ft. length.

TABLE H.*

Stormwater pipes running ½ full using formula $V = C\sqrt{RS}$ and C by Kutters formula with n = ·013.

Grade	6″ Pipe	8″ Pipe	18″ Pipe
	V. ft. per sec.	V. ft. per sec.	V. ft. per sec.
1 in 10	8·0	10·0	18·5
1 in 20	5·6	7·1	13·1
1 in 25	5·0	6·3	11·7
1 in 33	4·4	5·5	10·2
1 in 50	3·6	4·5	8·3
1 in 100	2·5	3·2	5·9
1 in 125	2·3	2·8	5·3
1 in 166	1·9	2·5	4·6
1 in 250	1·6	2·0	3·7
1 in 500	—	1·4	2·6

TABLE I.*

Diameter Unity.

d. Depth	p. Wetted perimeter	a. Cross-sectional area of flow	Corrected proportional velocities
Full 1·0	3·14	·785	1·0
·9	2·50	·745	1·15
·8	2·21	·674	1·16
·7	1·98	·587	1·14
·6	1·77	·492	1·08
·5	1·57	·393	1·0
·4	1·38	·293	0·88
·3	1·16	·198	0·72
·25	1·05	·154	0·65
·1	0·64	·064	0·36

TABLE J.*

Materials moved by flow.
Du Buat Experiments.

	Bottom Velocity ft. per sec.	Mean Velocity ft. per sec.
Pottery Clay	0·3	0·4
Sand size of anise seed	0·4	0·5
Gravel size of peas	0·6	0·8
Gravel size of beans	1·2	1·6
Shingle 1″ diameter	2·5	3·3
Angular stones 1½″ diameter ..	3·5	4·5

* Tables H, I and J based on information from "Sewerage" by Dr. A. Prescott Folwell.

From the foregoing it is easy to understand that by increasing the grade of a drain or sewer the velocity and the discharge increases. This means that the steeper the gradient of a street the smaller will be the pipes of the sewer or drain needed to take a given quantity in a given time.

With foul sewers engineers usually use a minimum size pipe of 6″ diameter although some may use a minimum size of 4″ diameter. When minimum sizes of pipes are used it is obvious that some sewers will never flow half-full which is the depth used in designing velocities. This condition occurs at the top ends of roads where only the flow from a few houses enters the sewer. As more houses are connected the flow increases on the way down the length of the sewer. A sewer therefore requires a steeper grade at its upper end than lower down.

Figure 40 illustrates the effect of the street gradient on a sewer. It is of course only flat grades that must be considered in this manner for where grades are steeper than required by the sewer, the latter will be laid parallel to the surface of the street or road.

Figure 40 illustrates that the road surface grades in C will result in the least amount of excavation for the sewer line whilst those in B will result in most. A falls between these two. The concave road surface gradient is not only the most economical for sewerage but is also aesthetically the best form and that shown in B is the worst.

Stormwater Drainage

Stormwater is carried by means of surface channels or gutters as well as in underground drains. Usually the flow is along surface gutters first and from there led into underground pipes.

Surface gutters or drains are practically forced to follow the longitudinal grades of the streets or roads although where these are very flat a small amount may be gained by grading the drains slightly steeper than the road surface. Surface drains work well at grades of 1 in 300 and where conditions force it 1 in 400 may be used. The ideal grade is however 1 in 200.

With underground drains there is more scope and these may be laid steeper than the road surface grades where desired except that of course any departure therefrom will result in increased excavation.

In well-developed townships surface drains do not carry the stormwater more than to the end of a block before the water is discharged into a catchpit of an underground drain.

It is best to design blocks to be lengthwise on to the contours in order to give the underground drains steeper grades and so reduce their sizes.

Figure 40 D and E illustrates this ; in both cases the length of the underground drain will be the same but in D the grade will be steeper and therefore smaller pipes may be used. The time of concentration will also be slower in the case of D and this also reduces the required pipe sizes.

Referring back to Table H it will be seen that a grade of 1 in 50 for an 18″ pipe will give a velocity and therefore also a discharge of twice that of a grade of 1 in 200 for the same size pipe.

Effects of Bends and Junctions

These retard the velocity in both stormwater drains and foul sewers and thereby reduce the discharge of such drains and sewers. This effect however on discharge is not usually of great importance and may mostly be ignored.

Bends and junctions however increase costs because manholes must be constructed at such points. If however they are made to occur where manholes would ordinarily be needed very little cost is added due to them.

It is usual practice to space manholes on foul sewers at distances of 300ft. apart, but there are some engineers who favour a distance of 250ft. and others who stretch this distance to 350ft. The spacing distance of manholes has been arrived at from experience in rodding and clearing sewers. If the length between manholes is too great difficulty is experienced when rodding as the whole force in pushing the rods is dissipated in the bending of same that takes place.

A curved road made up of chords of 300ft. or bends occurring at 300ft. or multiples thereof will not increase the number of manholes required over that of a straight road whereas one of 200 or 400ft. chords certainly would do so.

4. WATER MAINS AND ELECTRICITY RETICULATION

Gradients of streets or roads do not affect electricity reticulation nor, except on rare occasions, water reticulation. Both of these systems are affected by bends and junctions in roads.

Fortunately their cost is comparatively low as compared with the cost of developing townships. Both costs and difficulties are increased by bends and junctions and this should be clearly understood as well as taken into account when laying out a township.

In the case of water mains, bends and junctions result in the necessity of special fittings. There is of course no way of spacing bends to reduce this.

Bends have no effect on cable systems but on overhead electricity distribution systems they result in the necessity of staypoles and this increases costs. It also increases difficulties, for stays are a nuisance on footpaths or in gardens. In some cases flying-stays must be resorted to.

Sometimes the best method is to make use of lengths of cable at bends in order to avoid staypoles altogether.

Telephone systems are usually by means of overhead-wire systems. The difficulties arising from bends therefore are the same as in the case of electricity overhead distribution.

The spacing of electric and telephone poles must be considered when designing a township. Poles are usually spaced 150ft. apart and this is fortunately a multiple of 300ft. which is the distance to observe for the spacing of manholes on sewers.

5. INTERSECTIONS AND JUNCTIONS

Junctions on main roads should be planned to allow for a traffic circle of at least 120ft. diameter. This diameter should be increased up to 200ft. depending on the importance of the roads. Special junctions must be designed on national roads and allowance made for future bridges or subways.

Most junctions fall into the category of a Y- T- or right angle junction.

On minor roads no provision is required for circles at junctions as these will be either controlled by the stop-street or robot systems.

All corners at junctions should be splayed to give a sight line which allows at least 120ft. from the intersection point (see Figure 41.)

This distance is based on the speed of 30 miles per hour and for main roads where the speed is 40 miles per hour the distance should be 200ft.

The clear sight line need not be obtained entirely by the splay but may be achieved partly by splay and partly by building line restriction. The splay recommended is shown in Figure 41.

For main roads the splay should be determined in each case. For minor roads 50 and 60ft. wide, the following splays in Cape feet will give the approximate result :—

Building Line	*Corner Splay 50ft. Road*	*Corner Splay 60ft. Road*
30ft.	30ft.	20ft.
25ft.	35ft.	25ft.
20ft.	40ft.	30ft.

Staggered crossings encourage vehicles to cross diagonally across the main road unless prevented by centre islands. If not properly designed they may be dangerous. At least a distance of 200ft. should be planned from centre to centre of the staggered entrance roads. They do prevent vehicles shooting straight across a main road at a high speed out of the minor road. This is the greatest virtue of the staggered crossing.

The right angle crossing is simpler and considering all the points for and against it is to be preferred to the staggered crossing.

Y-junctions are the simplest and best form of junction but of course are limited to three directions. The three-way oblique junction as shown in Figure 41 E is suitable for main roads if designed as in

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the figure. Where residential roads intersect or meet main roads or other minor roads the junction should be as far as possible at right angles. The right angle entrance gives the best field of vision.

Oblique angle junctions facilitate movement in one direction and give good vision in one direction but are bad as to movement and vision in the opposite direction.

T-junctions are good when at right angles. The entrance of a branch road may be emphasised to advantage as shown in Figure 41 O by means of a road bay opposite the branch road. This has value both from traffic and aesthetic considerations.

Oblique junctions or crossings cannot always be avoided especially on steep sites where everything must be done to reduce road grades. In the case of two main roads an oblique crossing can be eased by the introduction of a traffic island. Where a minor road crosses a main road at least one entrance should be at right angles as shown in Figure 41 H.

Figure 41 F and G show bad designs of such crossing whereas in Figure 41 H the correct method is shown. The bad designs in Figure 41 F and G allow the traffic to pass diagonally across the main road whereas the correct design forces traffic to cross at right angles.

Where more than four roads meet, the junction should always be designed to allow of a traffic circle of at least 120ft. in diameter. In the case of junctions of main arterial roads the circle should be at least 180ft. diameter.

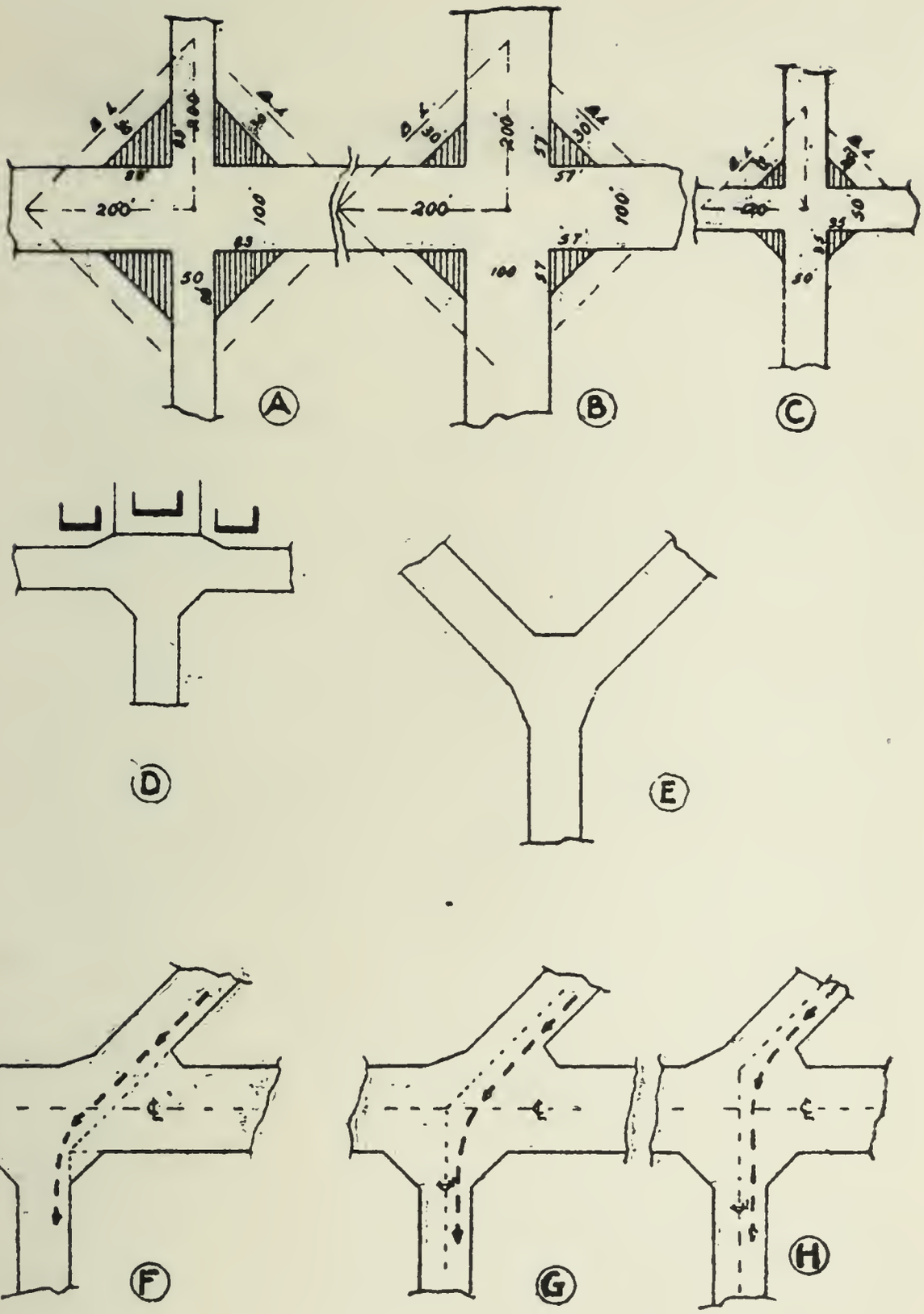

Fig. 41

STREET JUNCTIONS

Chapter VII

BUSINESS CENTRES

1. Local Centres
2. Main Centres

1. LOCAL CENTRES

Size of Business Area

Local centres differ from the main shopping centres of towns in that they are all based on similar factors. Main centres differ from each other for every town. A local centre will serve little more than the residents enclosed in a circle of a half-mile radius whereas town centres serve districts up to as much as 200 miles distance in some parts of the country.

The size of a local centre depends on the density of the population, which in turn is fixed by the size of the erven, within the half-mile circle. (Table M). In some townships it is often better to design a larger main local centre and then to provide areas more than half-a-mile away with small sub-shopping centres. This was adopted in the township shown in Figure 11.

In such cases the municipal and government activities as well as such uses as cinemas and those requiring a large population to exist will be sited in the main local centre. The sub-centres will then be for shops such as grocer, tearoom, butcher, chemist, greengrocer and draper.

A study of suburban shopping centres in Johannesburg revealed that one shop per 150 persons is the right proportion of business to allow for the population of a suburban township. This includes allowance for banks and a few offices.

The general size of local shops is about a 20ft. frontage and if three of these are reckoned to an erf of 60—70ft. frontage, a proportion of one business erf per 90 residential erven is arrived at if the figure of 5 persons per house or residential erf is taken.

Another method of arriving at the proportion of business is by frontage.

A study of South African towns indicates that one foot of business frontage will serve 8 persons in suburban townships. This works out to one 20ft. frontage shop per 160 persons and one business erf of 60ft. frontage to 96 residential ones or say 100 residential erven.

These figures are for Europeans and it has been found that half of this is required for Non-European suburbs.

Cinema and garage sites may be considered separately from the general business areas.

It was found in a study* carried out that it needed 3,000 persons to support a garage and more than 4,000 to support a cinema. The need for garages depends somewhat on the character of the township, as well as on the volume of passing traffic and so the figure given must be used as a rough guide only.

In many townships the foregoing proportions are not adhered to and in some of them elaborate centres or large numbers of business erven have been planned. Such planning not being practical or related to fact results in bad development.

Cinema sites are planned in many townships of a few hundred erven whereas it required a population of some 800 erven to support a cinema. Many of these sites are therefore doomed to remain vacant.

If too few business erven are planned flourishing shopping centres will result for a shop is elastic of space as to service and few suburban shops or small town shops could not easily do 3—4 times the trade on the same premises. It may result however in certain useful and needed varieties of business being kept out for want of a site. Another result may be that speculators acquire the business erven and hold them for high prices or the shopkeepers may hold vacant erven to prevent rivals being established. The result of this all will be that the population of the area will suffer from lack of certain shopping service.

The evils of too large shopping centres are far greater and shops spread apart with dwellings or vacant erven between them are the result. The owners of such erven rarely realise that there never will be a demand for business on all the erven. Most of them live in hope and in order not to baulk this hope dwellings of as poor a type as the authorities will allow are sometimes built in order to reap some return on their investment. Such buildings are often rooms built well back on the erven with the idea of erecting shops on the front portion later on.

An exact estimate of the number of erven required for business in any township cannot be made but near approximations are possible. Remember that it is better to have too few than too many shops provided of course that there are sufficient for competition and to give the necessary variety of services.

The more a township is developed for the higher income groups the less will be the local shopping. It is in areas where weekly paid workers live that the biggest local shopping centres develop.

Table K at the end of the chapter gives the number of persons required for each type of shop.

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* "Zoning in its relation to the Use of Land and Buildings," by T. B. Floyd, *Minutes of Proceedings S.A. Society of Civil Engineers*, Vol. XXXII, 1934.

Situation

The scattering about of business and other buildings and uses which are centres of concentration for persons is bad, firstly because good and direct access cannot be planned in a multitude of directions. Secondly it is inconvenient because, particularly in the case of shops, people economise time if the shops are close together in a group and movement can take place easily from one to the other.

Shops and business premises detrimentally affect the adjoining residential areas. By grouping them together the contacts with residential uses are greatly minimised.

A local centre may be a grouping of business, recreation, school, churches and park with the last mentioned used to separate the business and amusement uses from those of education and worship. An alternative is to group the business and amusement buildings together in one place and the schools and churches in another.

Business centres may either be planned adjoining a main arterial road or they may be sited in the centre of townships. They should never be planned as ribbons along main arterial roads for then the local traffic and parked vehicles hinder through traffic and vice versa. Where adjacent to such roads the centres should be set off in a square or bay in order to keep local shopping traffic entirely separated from the through traffic.

Placing business uses along a main arterial road and providing a service road to these uses is not satisfactory. Such a solution creates a bad shopping centre because the wide street widths provided destroy the intimacy of the centre and make it difficult for pedestrians to cross from side to side. Much of the parking will still take place on the main road in spite of service roads.

If a township is planned on the super-block principle a business centre placed in the centre of such a super-block will be away from the main feeder roads. It will therefore not be convenient to bus services and will draw delivery vehicles through the quieter residential areas to arrive at the shops. On the other hand it will be nearer to the greatest number of residents as compared with a centre adjoining a main feeder road.

Local shopping centres are the gathering place for the native servants of the neighbourhood and this can take place near main feeder roads with far less annoyance than in the centre of residential areas. Adjoining the main feeder roads shopping centres will be on bus routes and heavy delivery vehicles need not penetrate far from the main routes to deliver goods.

Where the method has been adopted of planning a main centre with small shopping sub-centres as shown in Figure 11 it is better to place the main centre adjoining main feeder roads and between the super-blocks. The sub-centres should then be situated internally in the super-blocks for in such cases they will consist of a few shops only. This is rather a good system to adopt. Should the main feeder road also be a main arterial road such as a national road or impor-

tant provincial road the main business centre ought not to be located on such road and if this is done it should be set well back in a square.

In small towns the position is quite different for there the Natives go home to the locations at nights and week-ends and do not gather about the shopping centre to such an extent as to be an annoyance. The business centres of small towns are quiet at night and on Sundays and therefore to have a church in such a centre is no disadvantage at all but is very fitting.

A level site should be selected for the business centre. Sloping sites if steep are bad. Sometimes circumstances are such that the business centre must be on a fairly steeply sloping site. In such cases they should be planned along the contours as shown in Figure 42 A and not at right angles to them as in Figure 42 C or diagonally across them as in Figure 42 B.

Planning along the contours enables the roof lines to be continuous and gives the best effect. It is easier in such centres for pedestrians to move about and for cars to park. It results where cross-slopes are steep in excavation on the top side and high foundations on the lower side.

If planned across the contours at right angles a good result is obtained on nearly level sites but where slopes are steep roofs and floors must be stepped. Foundations are less costly than where building takes place along the contours but this is somewhat off-set by extra cost of roofs. Road making is simpler and less costly but such centres are difficult for pedestrians and parking of vehicles. The effect of the stepped roof lines is not so good for they increase costs considerably. Floors have also to be stepped and difficulties at doorways often arise.

Placing the business centre diagonally across the contours combines the disadvantages of both the abovementioned. Difficulties with roof lines and floors occur as in the case where the shops are planned across the contours on steep sites. Roof costs are more than when planning along the contours. Aesthetically the worst effect is obtained when planning diagonally across the contours for the roof lines present a skew stepped appearance.

Figure 42 D shows a method of getting over the difficulty of a site lying diagonally across the contours.

On steep sites business centres planned across the contours result in steep footpaths which when paved are often slippery. Such footpaths also give rise to difficulties with perambulators when women are shopping. The parking of vehicles is also much more difficult on steep roads than on ones of easy grade.

The frontispiece illustrates a business centre planned along the contours and Figure 43 shows one planned across the contours.

Design

When designing business centres the grouping of the buildings which will later be erected must be visualised. A rough birdseye

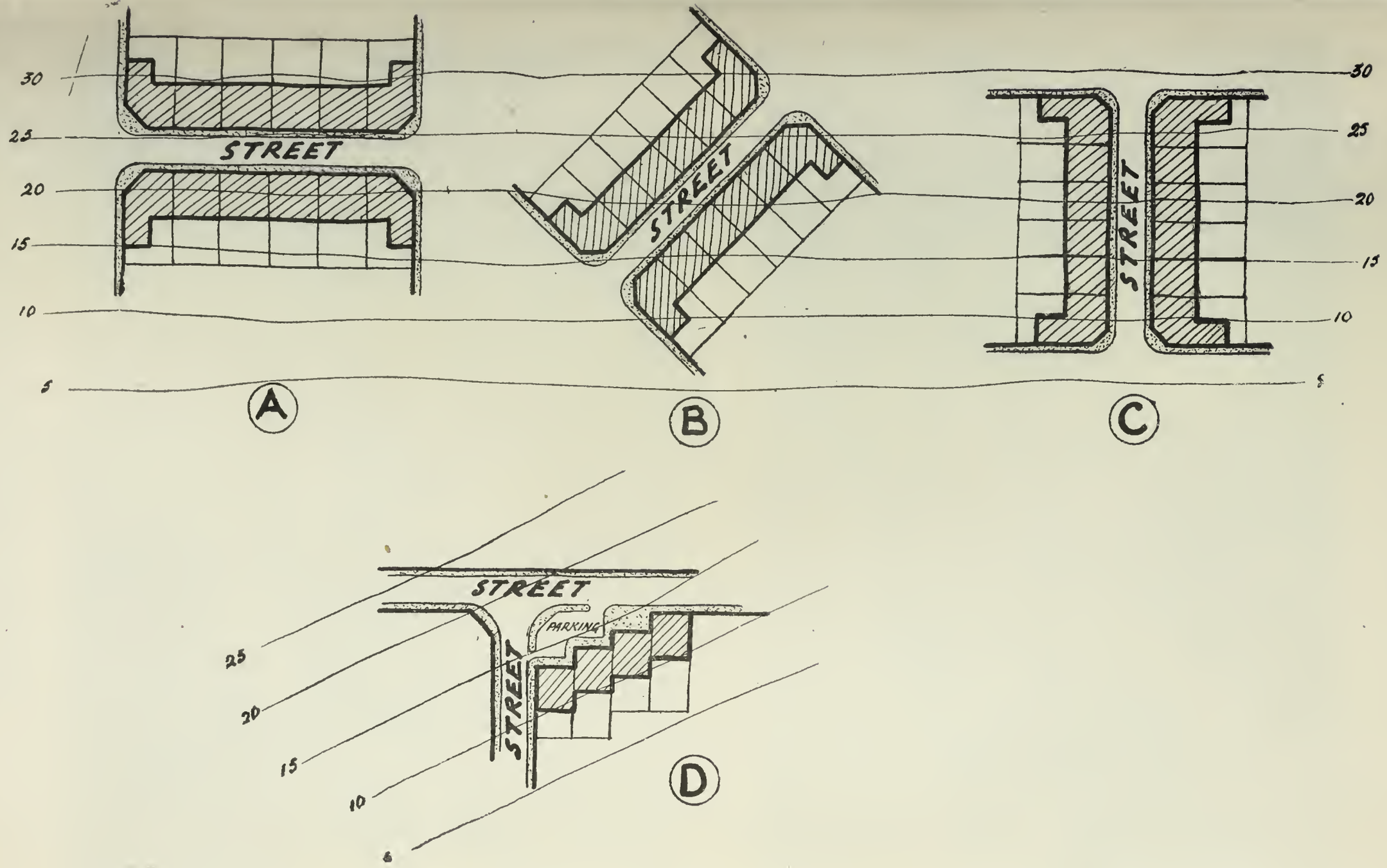


Fig. 42

SHOPPING CENTRES ALONG, DIAGONALLY AND ACROSS CONTOURS

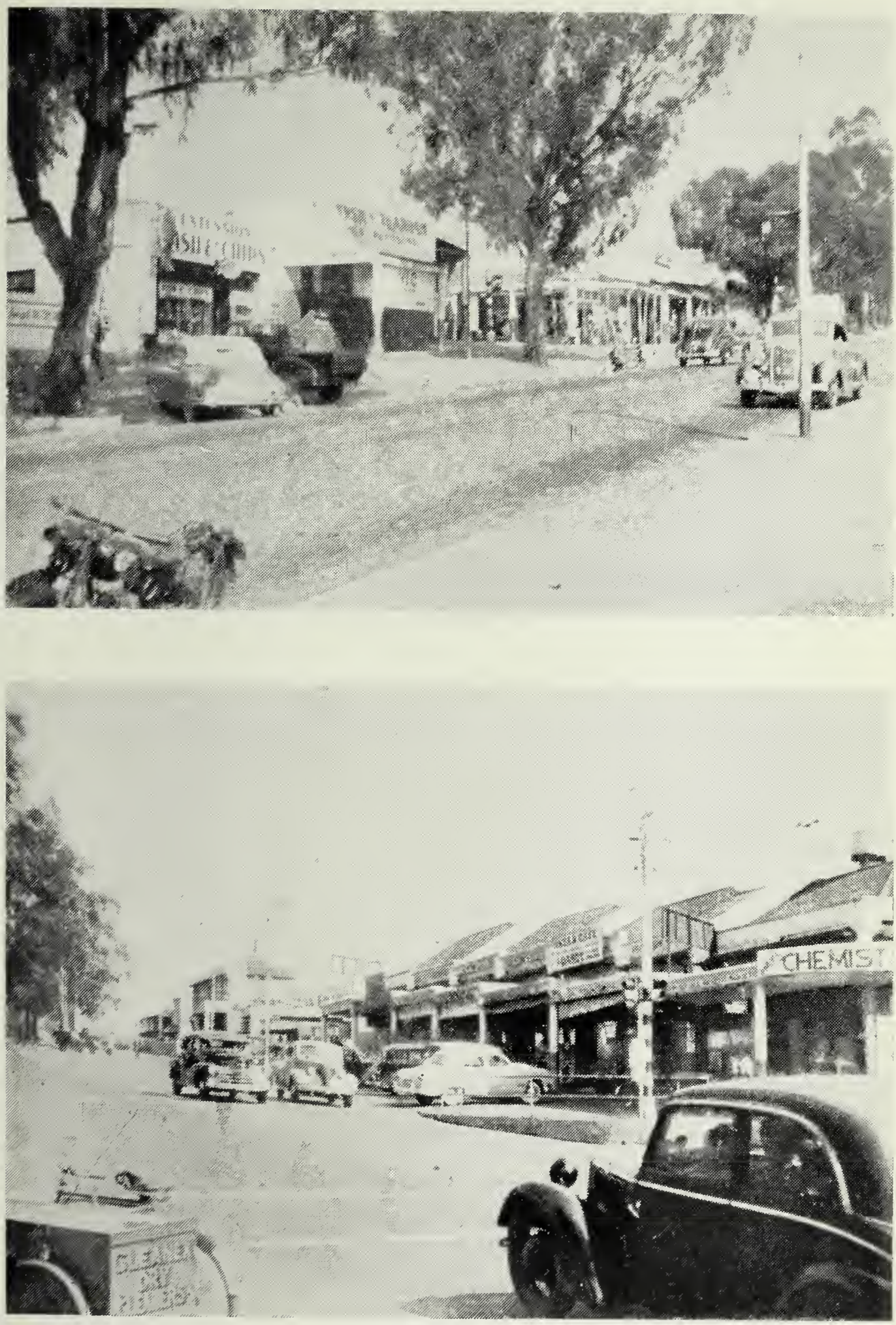


Fig. 43
SHOPPING CENTRE ACROSS CONTOURS
MULDERSDRIFT ROAD, MELVILLE, JOHANNESBURG

perspective showing how the buildings may be grouped is very helpful and may lead to amendment and improvement of the design.

A local business centre may be designed on formal lines, such as a strip along a road, a business block or a grouping around a square or a bay. It may alternatively be designed on entirely informal lines.

The simplest form is that of a strip along a road and this is the usual form that grows up when centres are not specially designed. In old townships these strip centres occur commonly along the main roads, resulting in traffic troubles and accidents. The concentration of local traffic and the parking of shoppers prove to be a real source of nuisance to through traffic and vice versa.

The strip form of shopping centre lacks individuality and is never satisfactory if large for then a long strip results which increases distances for shoppers and often makes it difficult to retain an easy grade on the footpaths. A short strip terminated by some dominant feature such as that illustrated in the frontispiece may be very good.

An important factor is the width of the street between the shop fronts. In shopping centres there is the conflict between the convenience of the pedestrian and that of the motorist. Pedestrian shoppers are the predominant ones and should therefore be given prime consideration.

The most convenient state for pedestrian shoppers is one where there is no vehicular traffic to hinder their movements. This is, however, impossible except for very small local centres or for small portions of centres. Vehicles must be able to approach close to shops in order to deliver or despatch goods and to convey shoppers. The former may be given approach at the back but this cannot be done satisfactorily with the latter.

It may be stated that the narrower the road between shops the safer and more convenient it is for pedestrians.

If vehicles are considered it is found that wide roads suit them best as such roads allow ample space for free movement and for parking. A wide road however considerably increases danger for it allows of high speeds being travelled.

The ideal width of a shopping street must therefore be one that allows parking space and free movement of traffic yet which is narrow enough to be easily crossed by pedestrians and to discourage speeding. It must be narrow enough for a shopper to easily see goods in a window across the road, if not in detail then at least sufficiently well to enable him to decide whether to cross or not.

Because of the parking and traffic difficulties so frequently seen in many existing local shopping centres a tendency arose to provide ample parking and traffic space but to forget the pedestrian. This tendency has resulted in wide roads even up to 120ft. between shops in townships. Such wide roads simply ruin a shopping centre.

The ideal street width between rows of shops in a local centre is 65 Cape feet. This allows for a carriageway of 42 English feet composed of two 11ft. traffic lanes for moving vehicles and two 9ft. lanes for slow moving or parking vehicles. A foot is allowed at each

kerb for gutters. Further, such a width makes provision for a footpath of 12ft. 6ins. wide on each side of the road. This width gives the minimum satisfactory width for vehicular traffic as well as the maximum safe crossing width for pedestrians.

A business centre should not be designed on roads where traffic requirements or the possibility of such be of a magnitude to necessitate a road width of more than 80ft.

The design of centres around bays or squares offers great possibility for variation. Such squares should, however, not be large. The aim should be to encourage pedestrians to move generally around the perimeter of the square along the shop fronts rather than to cut across it.

Squares can be made to provide ample parking space but if designed to encourage through traffic, they have the same disadvantages for pedestrians as wide streets. Both large squares and wide streets lack the air of intimacy so essential to a good local centre.

Arranging the local business premises in one block has the advantage of allowing shoppers to move from shop to shop without crossing any street. Such centre does however increase the length of shops fronting on to residences and other uses. It has therefore a greater detrimental effect on surrounding properties than any other type of shopping centre. This would particularly be so in suburbs of large cities where Native servants congregate at local shopping centres.

This type of centre facilitates parking but lacks intimacy. Its detrimental effects on surrounding properties may be eliminated by using parks or squares as buffers. Such an arrangement may be made quite pleasant. Topography may often however make it difficult to embody such a design in many townships.

The present craze to let parking be the chief consideration in designing a local shopping centre should be resisted.

Parking space should only be provided where it will be frequently used and where the area so set aside will be fully utilised. Excessive parking space means waste of land and money. The cost of unnecessary paving and the maintenance thereof can be a burden on a local authority.

Parking is most convenient at the side of a street. Back or out-of-the-way parking spaces should only be resorted to as a last resource. Above all avoid parking in a form that interferes with the movement of pedestrians on the footpath.

Loading lanes and back spaces are rarely needed in local centres and should only be provided where traffic is heavy on the front road. They add additional cost to the street area and may result in large areas of paving not being fully used or in simple words—waste.

Being at the back and thus out of the way they are certain to be used for improper purposes by Natives and will probably be dirty, unkept spaces where litter and waste products are strewn about by Natives.

Suburban shops seldom need more parking space than the kerb-side provides but uses such as a local hall, cinema, hotel and church require a large amount of parking space for a short period.

Figure 44 shows local shopping centres of different types which have been designed for various townships.

An informal design where the pedestrian approach is largely from the town hall gardens and sports centre is illustrated in Figure 44 A.

A back loading access is provided but this takes the place of front street approach and is therefore not wasteful. Being behind the police station abuse is not likely to take place. The parking area is placed convenient to the shops, recreation grounds, clubs and town hall and should thus be fully used. If not fully used part of it may be attached to the gardens.

Figure 44 B illustrates a combined cultural and business local centre suitable to a large suburb. A park is used to separate the school and churches from the business area. The streets can easily cope with the parking as this form of centre would be situated in the middle of a suburb and not near to a main traffic road.

The bay gives the greatest amount of intimacy possible in a one-sided shopping front.

A design suitable to a large or small suburb as well as the centre of a small town is shown in Figure 44 C. The figure illustrates a small centre. Note that the provision for parking is in the cross street which separates shopping from residential use.

Placed here it increases the break between the two different uses and also provides parking where it will not obscure shop windows and be a nuisance to pedestrians. Great intimacy is obtained in the shopping street which is only 60ft. wide.

No parking except loading will be allowed in this street and pedestrians will be able to easily move from shop to shop across the street.

The positions of the hotel and cinema will mean that there will be life day and night in this centre.

In Figure 44 D a centre around a square is illustrated. The centre is in full sight of the main arterial road yet off it. Local traffic can freely move without interfering with through traffic. It is a little spread and thus lacks close intimacy.

The positions of the hotel and cinema will bring life to the square in the evening and cause full use to be made of the parking facilities.

This centre is suitable for a large suburb or small town.

Figure 44 E shows a design suitable for a large township or small town. The square is small and with the large amount of shopping and business around it will not lose intimacy.

Ample parking space is provided and it is so situated that shop fronts and pedestrians are not interfered with. No parking should be allowed in front of the shops.

A simple yet very effective small shopping centre is illustrated in Figure 44 F.

Parking is kept out of the street between the two rows of shops for the reasons already stated. This street is narrow and the centre is thus compact and intimate. Such a centre should be situated inside a township away from main roads.

Figure 44 G illustrates a small centre which is designed on the principle of having the shops on one side of the main road only. A service road and bay are provided to keep the local shopping traffic off the main through route. Opposite the shops a park is sited to buffer off the shops from good residential buildings.

Both 44 F and G are suitable designs for small townships or as sub-centres in large townships.

2. MAIN CENTRES

Generally

The main shopping and civic centres of large towns or cities vary so greatly, according to circumstances that each is an individual problem of such magnitude as to be beyond the scope of this work. Rarely does an opportunity to design such a centre occur.

The designs of centres of small towns are fairly frequently met with if numbers of townships are laid out. These centres may vary from a row of shops or a group around a square to a centre covering many blocks and including a number of streets.

Small town centres may be designed on similar lines to those for local shopping in suburbs except that more provision is needed for civic buildings. Much said under the portion of this chapter dealing with local centres applies equally to town centres.

The location of main shopping centres must be carefully selected on flat sites. They must be centrally situated and be focal centres for the road system.

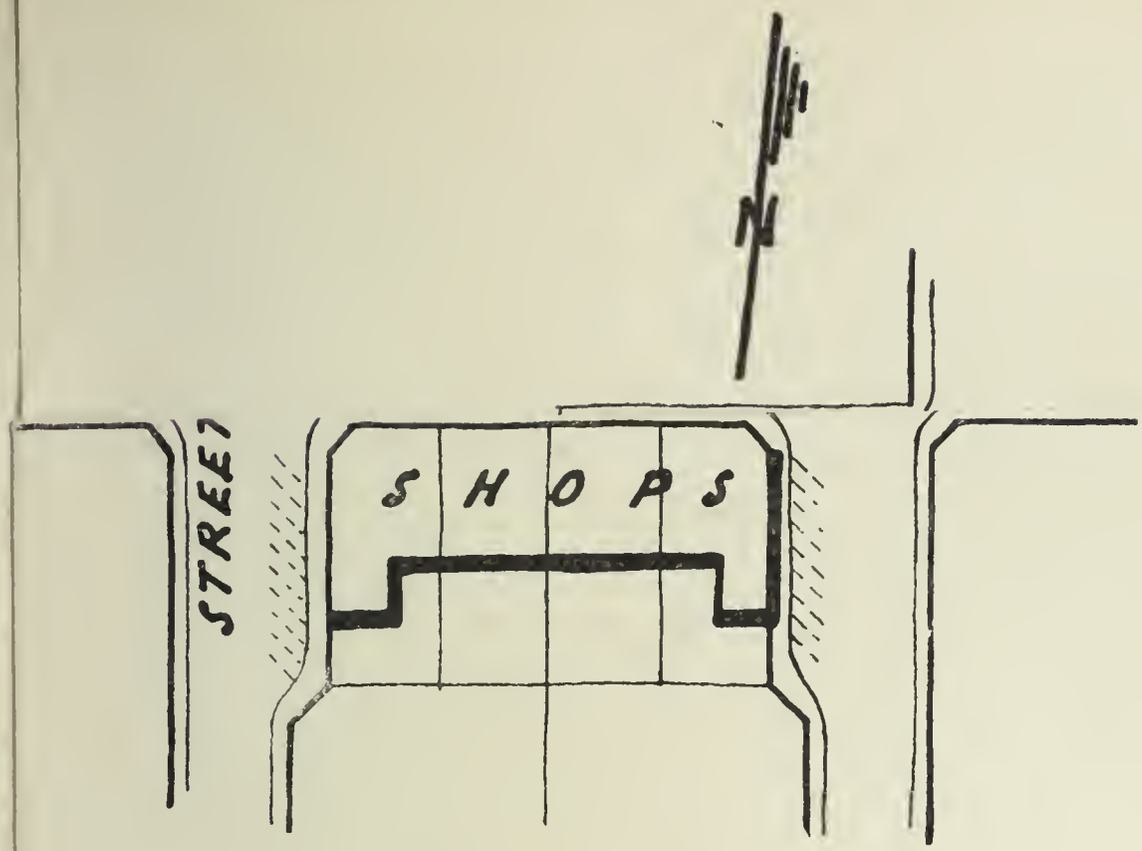
An important difference between the business centres of suburban townships and those of small towns is that the size of the former can be forecast with some degree of accuracy whilst with the latter this is less possible. The result of this means that the former may be finally planned whereas the latter must be so planned that it is elastic and growth possibilities even beyond expectation are not cramped or prevented.

The centre shown in Figure 5 is a good example of a town centre. It is between two main roads which make it very accessible yet allow through traffic to flow past.

Size of Area

In determining the size of the area of a main centre consideration must be given to the population of the district as well as the town.

District populations vary greatly in South Africa and the density of population on the land differs according to the type of farming. Average farms vary from 8,000 morgen in cattle ranching areas and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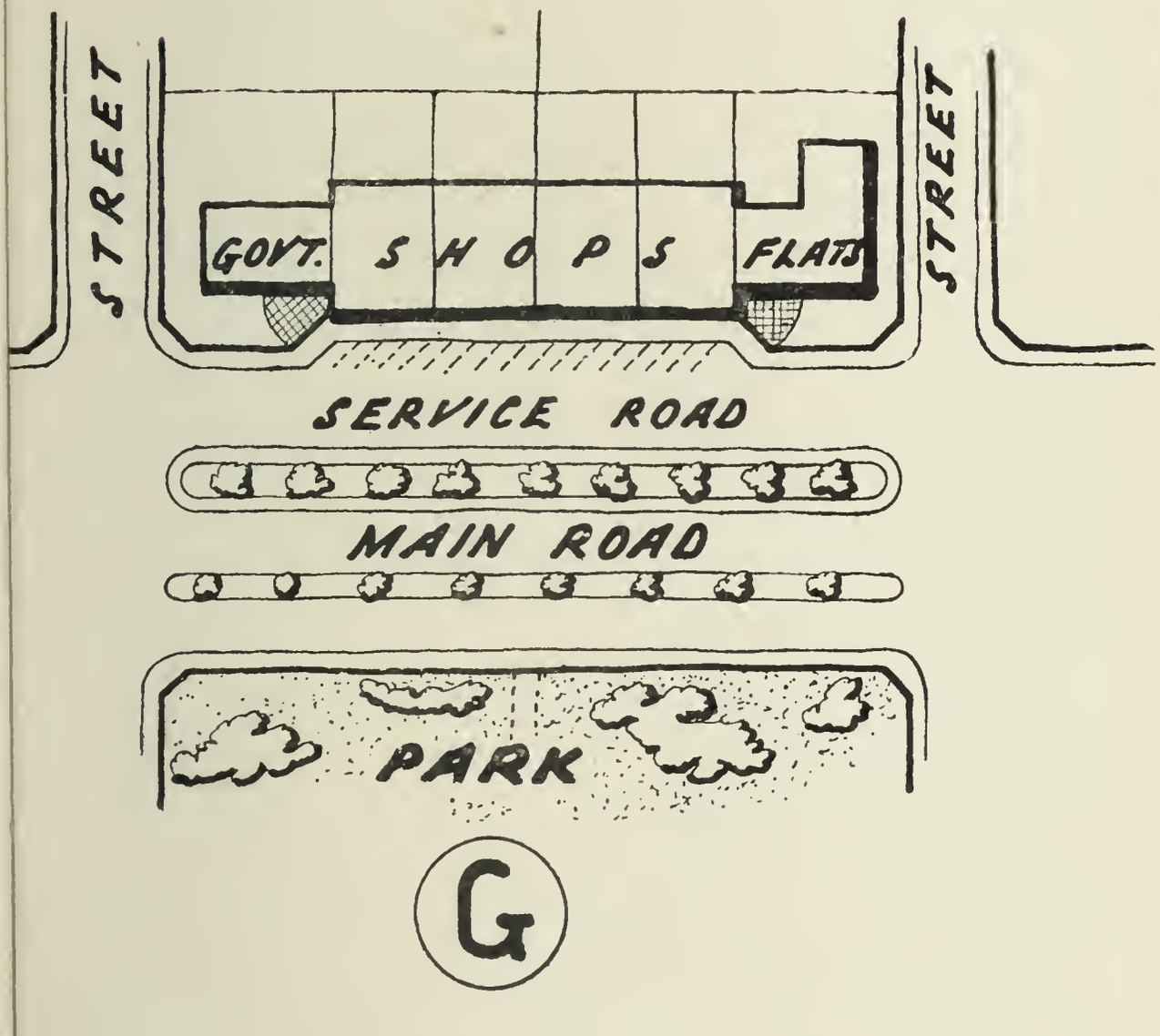
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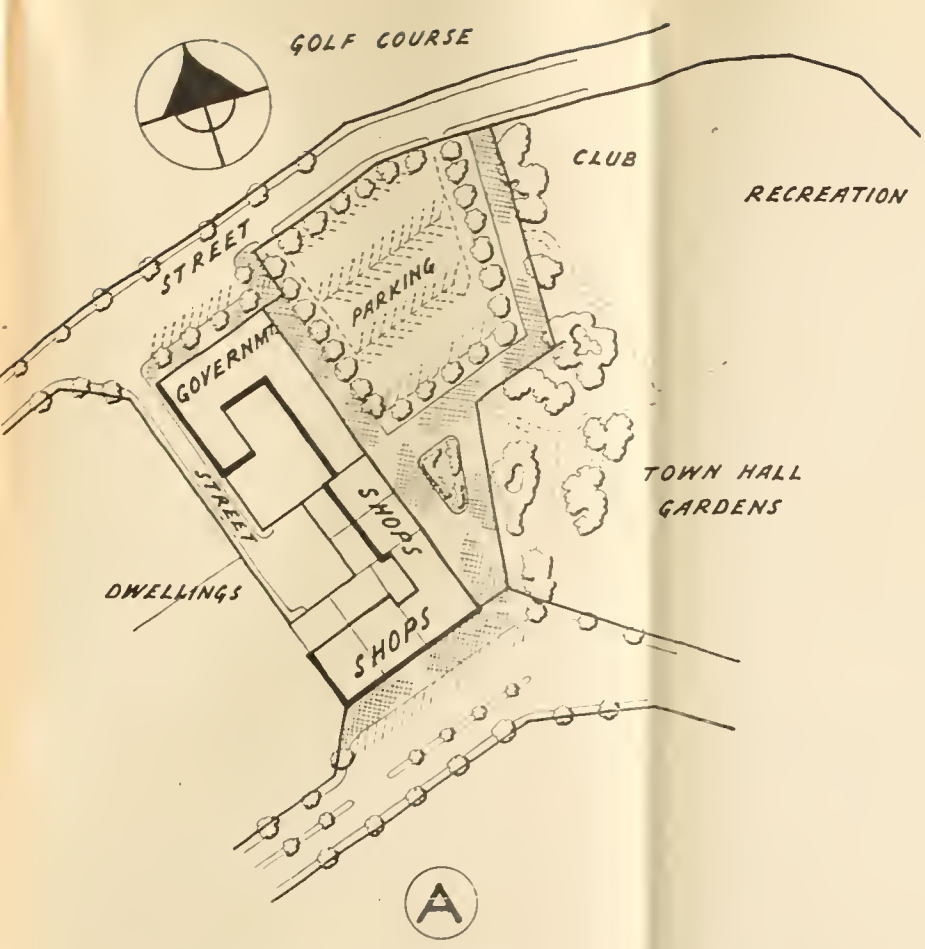

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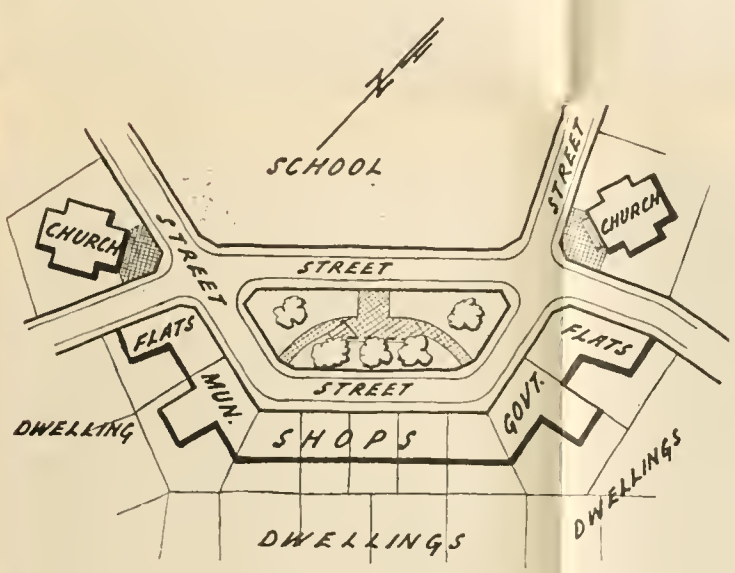

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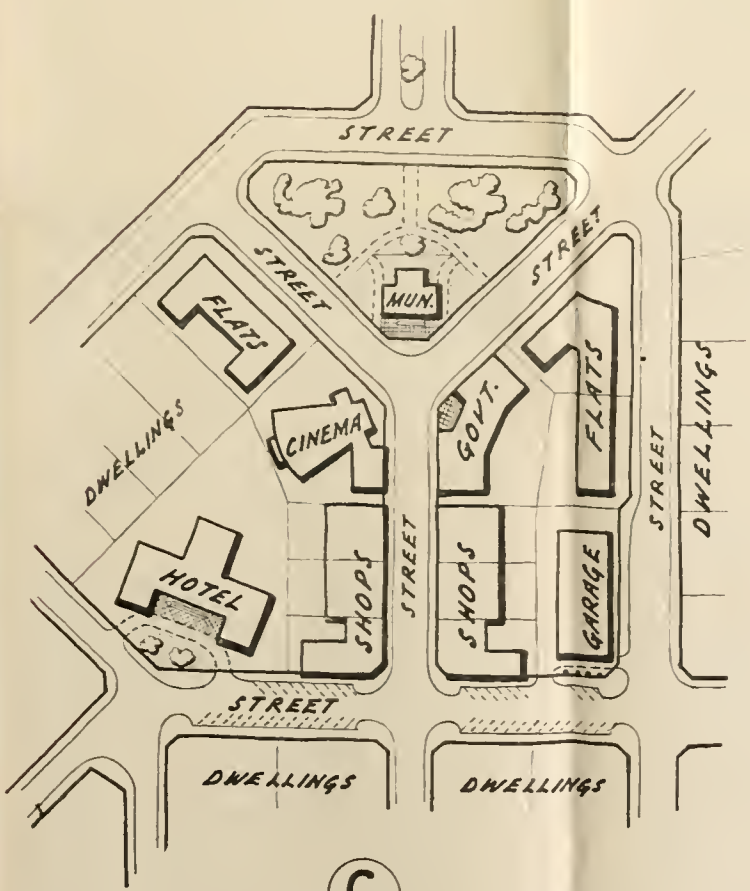

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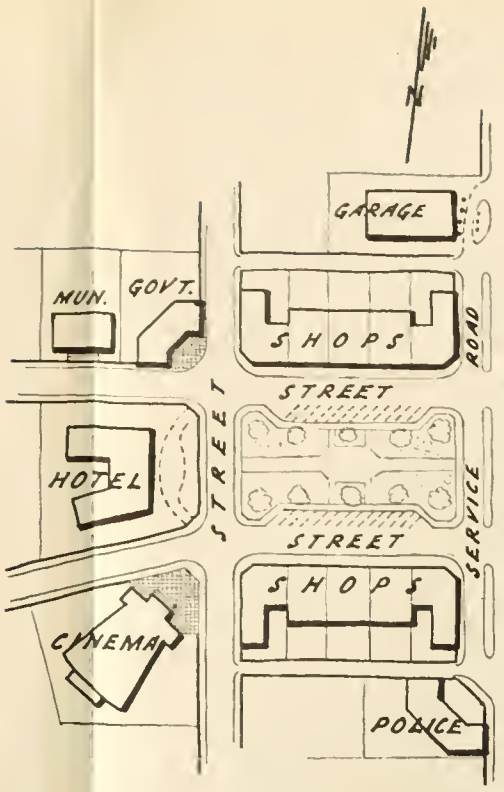

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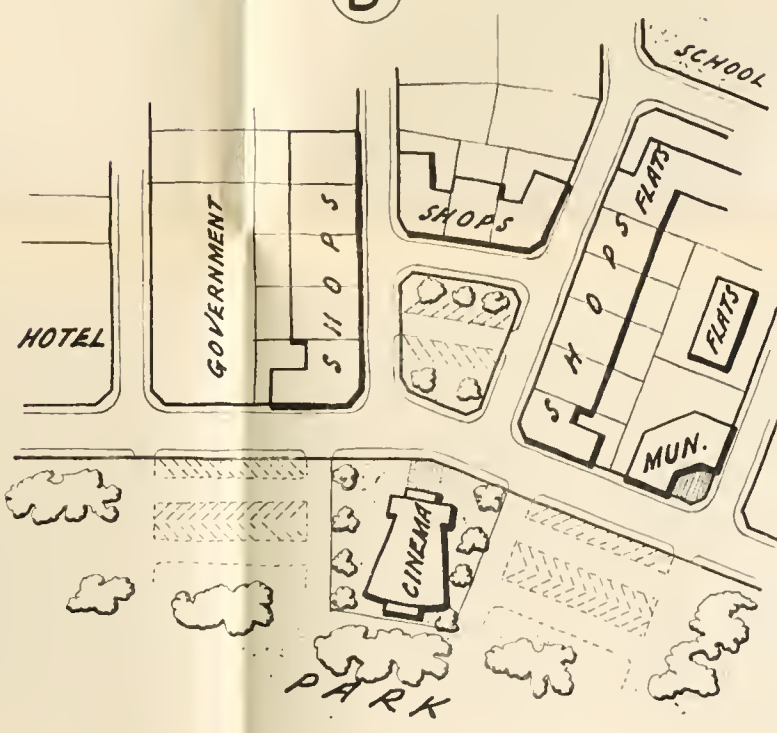

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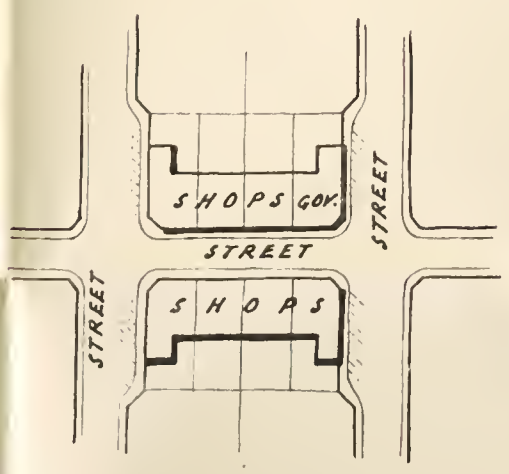

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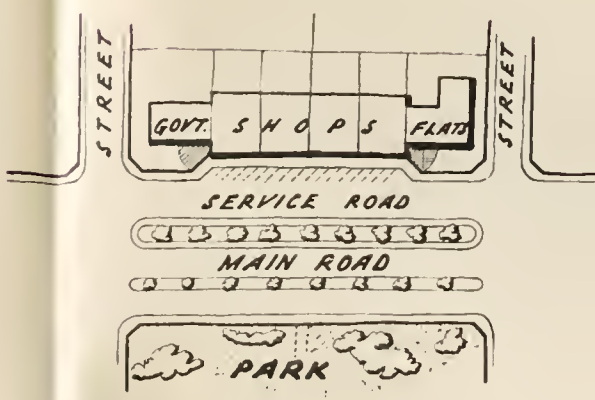

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Fig. 44
SHOPPING CENTRES

4,000 morgen in sheep ranching areas down to 300 in grain areas and 25 in fruit or other intensive farming areas.

Usually however the radius a town serves varies with the density of land population except where a town arises as a mining, industrial or seaside centre. Country towns serve areas varying from a radius of 10 miles up to one of 100.

Usually the smaller a town is, the more will its business come from the farmers. In fact country towns arise first as business centres for the farming community. In very large towns and cities the country trade becomes almost negligible.

When deciding upon the size of the business area therefore the district as well as the town population must be taken into account.

A study* of country towns revealed that there were 65 to 200 persons per business and that the average of a number of such towns worked out at 100 persons per business.

Frontages are extravagantly used in the country towns but may be taken as one foot per 3 to 5 persons of the town population.

A small town takes some time to grow as a rule and if the business centre is planned too large in the first instance, scattered business uses will result. The evils of too large a business centre mentioned under local centres apply to even a greater extent in main centres.

To avoid the above mentioned bad development a main centre should not be planned too large or for a population limit which is too far ahead. Provision must however be made for expansion and this is best done by providing residential erven which may later on be converted into business ones. Such erven will be restricted to residential use but this condition must provide that, after twenty years and with the Administrator's consent they may be used for business purposes.

Design

A main centre must provide for public buildings, hotels, cinemas, workshops and garages as well as for shops, offices and other business premises. Except for the very smallest towns squares should be provided for parking, public gatherings and to group buildings of a similar character. In towns of some size there may be a number of such squares, none of which should be very large.

Attempts have been made to isolate the vehicular traffic from the pedestrian. This can only be successfully achieved in very small centres or in small portions of larger centres. Arcades and pedestrian ways of not great length may with success be used to separate pedestrians to some extent from vehicular traffic. They are very suitable for offices, hairdressers, flower shops and shops selling small light articles which do not need to be delivered by vehicles. For many forms of business they are unsuitable and these usually avoid arcades.

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* " Zoning in its relation to the Use of Land and Buildings," by T. B. Floyd, *Minutes of Proceedings S. A. Society of Civil Engineers*, Vol. XXXII, 1934.

The provision and use of lanes and service roads at the rear of shops eliminates the nuisance arising from the offloading of delivery vehicles. It achieves this however at the price of almost doubling the road making costs. Obviously this is too great a price to pay especially when the conflict of offloading vehicles and shoppers can easily be eliminated by regulating offloading hours.

Rear lanes and service roads will however not separate delivery vehicles and pedestrians for pedestrians will also use these roads. They will result in half the streets in the centre of a town being lined with back premises and the aesthetic result will be ghastly. Another disadvantage of back streets or lanes is that the number of road intersections is considerably increased.

Back access roads are therefore not recommended for general use or use on a large scale but they may be occasionally used to advantage under special circumstances.

Nothing is more dismal in a town centre than a very large square with a fringe of shops around it. In many districts the rainfall is low and these large squares become dry, dusty, sun scorched and hot places, which are unpleasant to cross in the summer months particularly. Many examples exist in country towns. A large centre square may also have the bad effect of breaking up the main business centre into two portions as in Reitz. This is shown in Figure 45.

It is important to keep in mind that free and easy access and circulation of both vehicular and pedestrian traffic is essential. Bus stops and termini must be given careful consideration. These may vary from a simple stop at a shop veranda to the more elaborate bus station.

In large shopping centres it is essential that wide main roads of 80 to 150ft., depending on circumstances, feed direct into such centres as well as encircling them. The wide access roads should however stop on a wide inner ring road and all the internal streets should be 65 Cape feet wide or at most 80 Cape feet wide.

In the average town all the internal roads of a main centre should be 65 Cape feet. Less will mean congestion and inconvenience whereas wider will mean waste of land and road making costs, the destruction of intimacy and in many districts more dust. No internal business street whether in an average town centre or in that of a large town should have a carriageway of more than 42ft. wide nor should it be less.

Any main through roads, access or ring roads should have dual carriageways and in town centres each of these should be of three lane width.

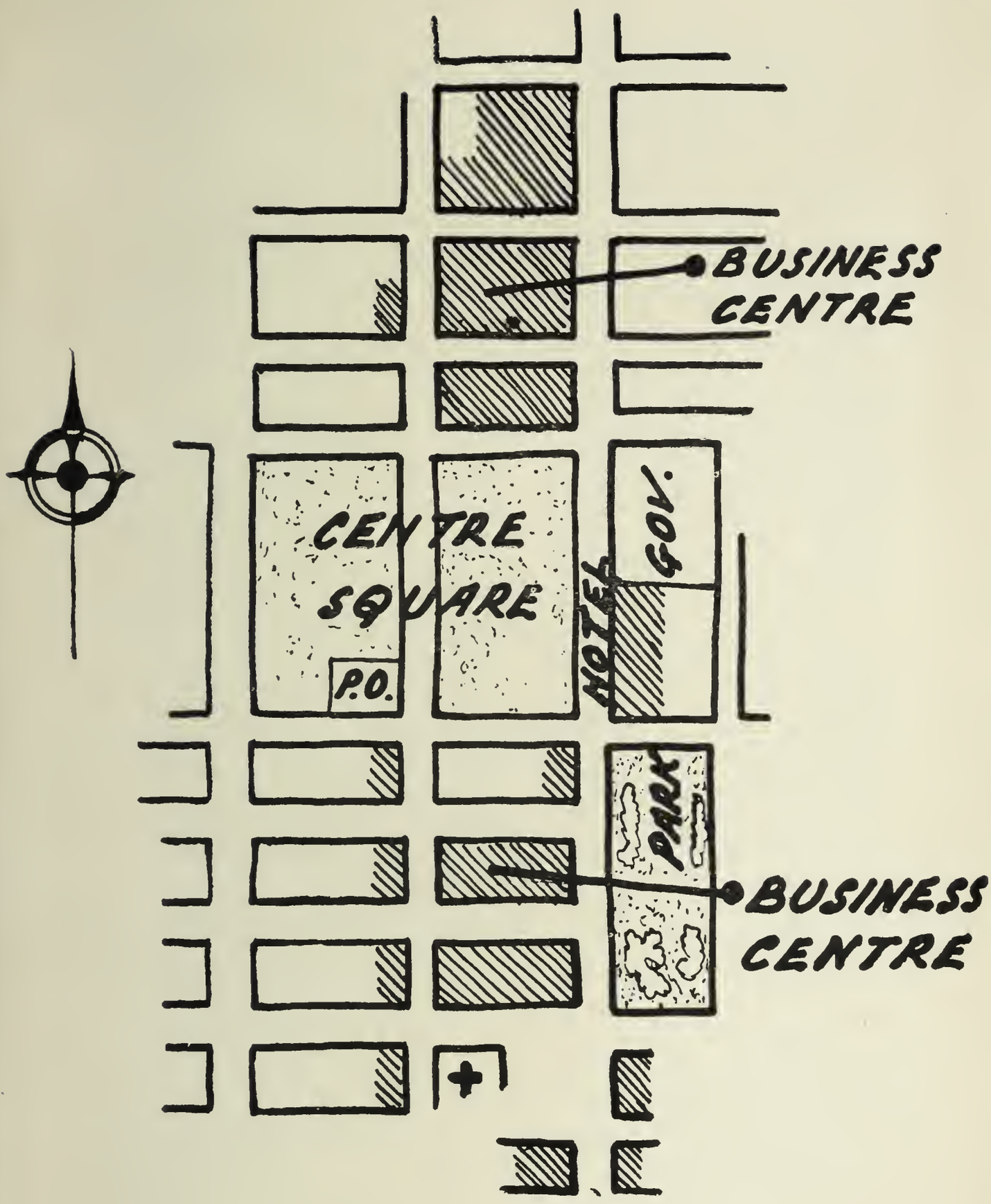

Fig. 45

SQUARE AT REITZ

TABLE K.*

Number of persons to various types of shops or business premises.

	Number of persons to one shop (Average)		Average of 7 American cities New York Regional survey	Number of persons to one shop or business
	City Suburbs	Town		
	based on 8 *suburbs*	*based on* 18 *towns*		
General dealer and grocer	500	400	Grocer	640
Draper and clothier	1,000	1,300	Millinery	6,500
Butcher	2,000	1,850	Shoe	5,600
Baker	4,000	3,500	Clothier	5,700
Chemist	2,000	2,800	Butcher	1,000
Cafe and tea room	4,000	2,500	Baker	2,800
Hairdresser	2,000	2,400	Chemist	1,700
Auctioneer	12,000	3,000	Restaurant	1,400
Garage and filling station	3,000	2,000	Tobacco	5,000
Cycle dealer	4,000	4,500	Coal	5,600
Greengrocer and fruiterer	2,000	5,000	Garage	2,200
Furniture	5,000	5,000	Cleaner and laundry	4,000
Tailor	—	2,500	Greengrocer and fruiterer	3,700
Watchmaker and jeweller	—	3,200	Furniture	4,500
Hardware	6,000	7,000	Tailor	2,200
Bazaar	5,000	7,000	Jeweller	6,400
Fishmonger	8,000	10,000	Hardware	6,700
Stationer and printer	6,000	2,800	Delicatessen	7,600
Bottle store	—	4,000	Dry goods	4,500
Bioscope	4,000	—	Musical instruments	9,800
Miscellaneous shops and offices	2,000	1,000	Department store	45,000
Total business	European area 1/150 non-European 1/400	Small town 1/100 City 1/100		

Note.—The number of persons to one business premises increases with increase in percentage of non-European population, or school population. The number decreases with increase of density of district, wealth of population, popularity as pleasure resort and distance from other towns. The number increases for a small town near to a city, but decreases for a city near to other small towns (radius approximately within 50 miles).
To quota of shops or business premises for small towns add two Banks, one Post Office and one Bioscope if over 2,000 population and not close to large city.

* " Zoning in its relation to the Use of Land and Buildings," by T. B. Floyd, *Minutes of Proceedings S.A. Society of Civil Engineers*, Vol. XXXII, 1934.

TABLE L.*

Number of persons to one business premises in various towns and Johannesburg suburbs.

Town	No. of persons to one business premises	Remarks
Barberton	82	—
Belfast	80	—
Bethal	68	—
Boksburg	200	Near large city
Carolina	130	—
Christiana	200	Poor area
Ermelo	105	—
Heidelberg	170	Near large city
Klerksdorp	165	Poor area
Lichtenburg	230	Poor area
Louis Trichardt	130	—
Middelburg	130	—
Pietersburg	130	—
Potchefstroom	188	School centre, Poor area
Rustenburg	150	—
Standerton	90	—
Vereeniging	120	—
Volksrust	110	—
Witbank	140	Large Native population
Zeerust	120	—
Bethlehem	100	—
Frankfort	70	—
Harrismith	80	—
Heilbron	65	—
Kroonstad	120	—
Caledon	62	—
Calvinia	90	—
Cradock	90	—
De Aar	120	Poorly populated district
George	81	—
Graaff Reinet	120	Large Native population
Queenstown	108	—
Worcester	110	School centre
Johannesburg Suburbs—		
Vrededorp Area	120	Serves other areas Poor area
Parkview	250	Well-off area
Rosebank, Parktown North area	150	Well-off area
Hospital Hill, Hillbrow area	150	—
Yeoville, Bellevue	168	—
Turffontein and Southern suburbs	120	—
Mayfair and Fordsburg area	115	Serves other areas Poor area
Melville	125	—

* " Zoning in its relation to the Use of Land and Buildings," by T. B. Floyd, *Minutes of Proceedings S.A. Society of Civil Engineers*, Vol. XXXII, 1934.

TABLE M.

Shops likely to exist in local centres of various sizes.

Radius Served in Miles	Density in Square Feet per Dwelling	Persons Served (5 per Erf)	Maximum Shops in Business Centre which population can support
¼ (125 acres)	5,000	3,000	6 General dealers, 1 draper, 1 butcher, 1 chemist, 1 cafe, 1 hairdresser, 1 garage, 1 greengrocer.
	10,000	1,700	3 General dealers, 1 draper, 1 butcher.
	20,000	1,000	2 General dealers, 1 draper.
⅓ (224 acres)	5,000	5,300	10 General dealers, 5 drapers, 2 butchers, 1 baker, 1 cycle dealer, 2 chemists, 1 cafe, 2 hairdressers, 2 garages, 2 greengrocers, 1 furniture store, 1 bazaar, 1 stationer, 1 bottle store, 1 cinema.
	10,000	3,100	6 General dealers, 1 draper, 1 butcher, 1 chemist, 1 cafe, 1 hairdresser, 1 garage, 1 greengrocer.
	20,000	2,000	4 General dealers, 2 drapers, 1 butcher, 1 chemist, 1 hairdresser, 1 greengrocer.
½ (500 acres)	5,000	12,000	Full range of shops.
	10,000	7,000	Full range of shops.
	20,000	4,000	8 General dealers, 4 drapers, 2 butchers, 2 chemists, 1 cafe, 1 garage, 1 cycle dealer, 2 greengrocers, 1 cinema.

Note.—To the large centres may be added 1 or more banks, and to all centres above 2,000 add one shop or office premises for every 2,000 persons.
The figures given are for small shops and one large shop occupying the area of two or three small ones may easily do the business of 4 or 5 small shops and displace them.
An area served by ⅛ mile radius, at a 5,000 square feet density, would support only a general dealer's shop and at densities of 10,000 or 20,000 square feet per dwelling could not support a shop.

Chapter VIII

OPEN SPACES, PARKS AND SCHOOL SITES

1. Open Spaces and Parks
2. School Sites
3. Special Open Spaces

1. OPEN SPACES AND PARKS

In this group of uses may be included wild parks, open spaces along streams and ridges, large parks, local parks, children's playgrounds, recreation grounds, formal gardens and informal gardens.

All these open spaces should be planned in a town as a complete park system. This means that the various types must be of correct area and spaced properly to suit the needs of the population.

The various open spaces may be linked up by park strips and parkways. Advantage may also be taken of park strips and public open spaces to lead up to or give access to schools, shopping centres and other places of concentration and thus enable pedestrians to approach such centres by means other than streets.

In previous chapters the situation of public open spaces has been dealt with in a general way and it is for this chapter to deal with particular needs, requirements and details.

Boulevards and parkways may be treated as part of the park system, but to properly deal with centre islands of streets or roads such islands must be at least 30ft. wide. Less than this width will not lend itself to good landscape treatment.

It is impossible to prepare a table showing how the acreage or percentage of the various public open spaces and park uses should be distributed and so this has not been attempted. It is usual to combine uses and this may be done in a variety of ways.

Taking the home as the centre point the various public open space uses should be distributed so as to be not more than the following distances from it :—

Children's Playground ..	$\frac{1}{4}$ Mile
Local Park	$\frac{1}{2}$ Mile
Large Park	$1\frac{1}{2}$ Miles
Recreation Grounds	$1\frac{1}{2}$ Miles
Wild Park or Picnic Grounds	6 Miles

Water supply, climate and soil must play a part when deciding on the types, positions and areas of all the various open space uses. The size of the town will also have an important bearing on decisions of this sort.

According to natural conditions in the country, town, development may be classified in areas as follows:—

(*a*) Sub-tropical areas,
(*b*) high rainfall areas,
(*c*) areas of moderately good water supply,
(*d*) dry areas.

(*a*) *Sub-Tropical Areas.*—In these localities where water supply in the form of rainfall or irrigation is good and where the soil is good, lavish provision may be made for parks and public open spaces. These may largely take the form of small open spaces of 1/10th to $\frac{1}{2}$ morgen* scattered about at frequent intervals. Such open spaces should be planted with trees to provide shady spots where persons may rest, small children play and cars be parked in the shade.

Open spaces of this type should of course be in addition to the normal area of public open spaces required in average towns.

(*b*) *High Rainfall Areas.*—Along the coast of our country there are a few areas of very high rainfall where township design may with advantage provide for numerous small open spaces as in the case of sub-tropical areas.

These spaces should however be planned and developed more for ornamental and aesthetic effect than for shade and would therefore be planted differently to small open spaces in sub-tropical areas.

(*c*) *Areas of Moderately Good Water Supply.*—Areas of this type comprise a large part of the country and the bulk of the townships to be planned will be in such areas for they are the most highly developed and populated ones.

Large numbers of small open spaces are not recommended in these townships, which for want of a better term may be regarded as the " average township."

(*d*) *Dry Areas.*—The larger portion of the country falls in what may be regarded as dry areas. In such areas rainfall is low and water supplies are usually poor.

Towns are few and far between and their growth is slow. It therefore follows that not many new townships occur in these areas. Very few new towns arise and the existing towns remain small. Few suburban townships are ever needed because growth is usually met by small extensions to the existing towns.

Parks and especially the flower garden type are very costly to establish and maintain. Public open spaces provided in township layouts may become barren patches giving rise to dust and unpleasant to cross in the blazing sun of summer.

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* 1 Morgen = $2\frac{1}{8}$ Acres.

It is therefore suggested that in the design of towns for dry areas provision should be made for a formal garden of not too large an area in the town. The only other public open space needed is a recreation ground and this should be on the outskirts of the town and only as large as is required for the playing fields.

These small towns in dry areas do not need the usual parks and public open spaces and cannot afford to do anything with them because of water difficulties. They are always surrounded by large commonages of open veld where people may roam and usually a dry river bed close by provides the playground for small children.

The design of towns in these areas should aim at as compact a town as reasonable in order to reduce dust surfaces to a minimum as well as reducing distances to be covered in a hot sun.

Any open spaces provided should preferably be planted with indigenous bush, trees and flowering plants.

The locations in these areas should be treated on similar lines to the little towns. Where thorn trees exist around them these must be strictly protected.

Suburban Townships

In most of these it is not required to provide public open spaces other than for local parks, recreation grounds and children's playgrounds. Usually two or all of these are combined together.

The topography of the site is often such that park strips along stream courses and ridges become necessary and may then with advantage be incorporated in the design.

Area of Site

Standard sizes of what the various open spaces should be cannot be laid down. In many cases there will be a combination of uses and this is here suggested.

Local parks ought to be large enough to make provision for children's playgrounds, tennis courts, jukskei pitches and or bowling greens. In addition there should be ample space left over where old people and others may peacefully rest under the trees.

In no case should the local parks be given over to recreation in the form of organised games to such an extent that the whole park is monopolised for such purposes. If the parks are not large enough for all the uses then the persons of the age group who play organised games are the best able to travel longer distances and should do so. The needs of the small children and old people should come first.

It is well therefore to plan the local parks large enough and they should be at least one morgen in area. The organised games ought not to occupy more than half the park leaving the other free for old people, children and others not taking part in organised games.

In cases where a rugby or soccer field is needed in a local park, the park area is best made 2 to 3 morgen at least. Where, however, the local park is for park and children's playground only $\frac{1}{2}$ morgen in extent should prove a suitable minimum area.

Spaces for children's playgrounds only may be as small as ¼ morgen.

It is not easy to draw a distinction between a local park and a large park but it is suggested that a large park may be considered as one not being less than 8 morgen in area and that any below this area would be a local park.

Any area above 4 morgen may be considered sufficient to be classed as a large recreation ground provided the whole area be devoted to organised games.

The recreation and sports requirements of towns vary and it is difficult to express the requirements in acres per 1,000 of population. Many towns cater for the surrounding districts and some are the sports centres of sub-provinces. These latter must provide for championship and sub-provincial events.

The unit shown in Figure 46 is suitable for most towns where the schools also use the central sports grounds and would provide for a town up to say 10,000 European population. The area required is approximately 14 morgen. For the average small town of the same size where the schools do not use the recreation grounds, less fields are required. The minimum area should however provide for two rugby fields, an athletic track, a soccer or hockey field, a cricket field, two bowling greens, ten tennis courts and jukskei pitches. This may all be done in the area of about 8 morgen. The alternative is not to have a central sports grounds, but a number of recreation grounds instead. A similar allowance is needed for the Non-European population.

Where a town grows much larger it is usually better to provide additional units than to increase the size above this.

The nett area required for the play space in children's playgrounds is 12 square feet per child. As playgrounds serve a quarter mile radius the probable number of children may be calculated from the density zoning or number of houses for which provision is made. Of course additional space is needed for trees, paths, and flower beds and therefore the playground area should be considerably more than the nett amount for the play space.

The areas to allow for playing fields of the various games are as follows :—

Rugby (Senior)	140yds. × 80yds.
(Junior)	120yds. × 75yds.
(Boys under 14)	100yds. × 60yds.
Soccer	120yds. × 80yds.
Soccer (Boys)	100yds. × 70yds.
Hockey	110yds. × 65yds.
(Junior) ..	100yds. × 60yds.
Cricket	Circle of 120yds. diameter
Tennis	40yds. × 20yds.
Bowls	50yds. × 50yds.
Jukskei	20yds. × 7yds.

Note that the sizes given above are overall sizes allowing for back and side spaces.

Athletic tracks are usually designed around a rugby field in order to economise space and the need of spectators grandstands. They are in such cases made $\frac{1}{4}$ mile in circumference.

All children's playgrounds should be provided with a paved area of bitumen or other suitable material where children may mark out and play the games which they usually do on the road surface.

2. SCHOOL SITES

Fairly flat and high-lying land is the most suitable for school sites. Flat land economises the cost of foundations of buildings as well as the construction of playing fields. Rocky ridges, water courses and broken ground should only be included in school sites if their area is additional to the required area of flat land.

Low-lying land is usually the easiest place to find flat areas but such sites are usually badly drained and difficult to drain. In addition to this good foundations for buildings are frequently unobtainable at a reasonable cost in such areas.

Primary school sites should not be more than half-a-mile from any home in a town and high school sites should not be more than two miles where public transport exists and one mile where no such transport is available.

The suggested area of school sites required is 3 morgen for primary schools and 8 morgen for high or junior high schools. Where schools accommodate both primary and high school pupils the area should be at least 10 morgen.

Details of these areas needed are as follows :—

	High School and Junior High School *Morgen*	Primary School *Morgen*
Site for buildings	1	$\frac{1}{2}$
Rugby fields (two)	2	$\frac{3}{4}$
Hockey fields (girls), (two)	2	$\frac{3}{4}$
Soccer field or Hockey (boys)	1	—
Tennis, Netball, Jukskei	$\frac{1}{2}$	$\frac{1}{2}$
General play space, and tree planted area	$1\frac{1}{2}$	$\frac{1}{2}$
Total	8	3

In small towns situated in dry areas it is recommended that school sites should be adjacent to but not in the town.

All school sites ought to be selected wherever possible in such a position that the buildings may conveniently face north and the playing fields lie north-south. Contour lines should therefore run north-south which means in other words that the greatest fall will be east-west. Slopes of this nature are the most economical sites to develop but this cannot always be easily obtained combined with the right aspect.

The flatter the site the less will the direction of the slope matter.

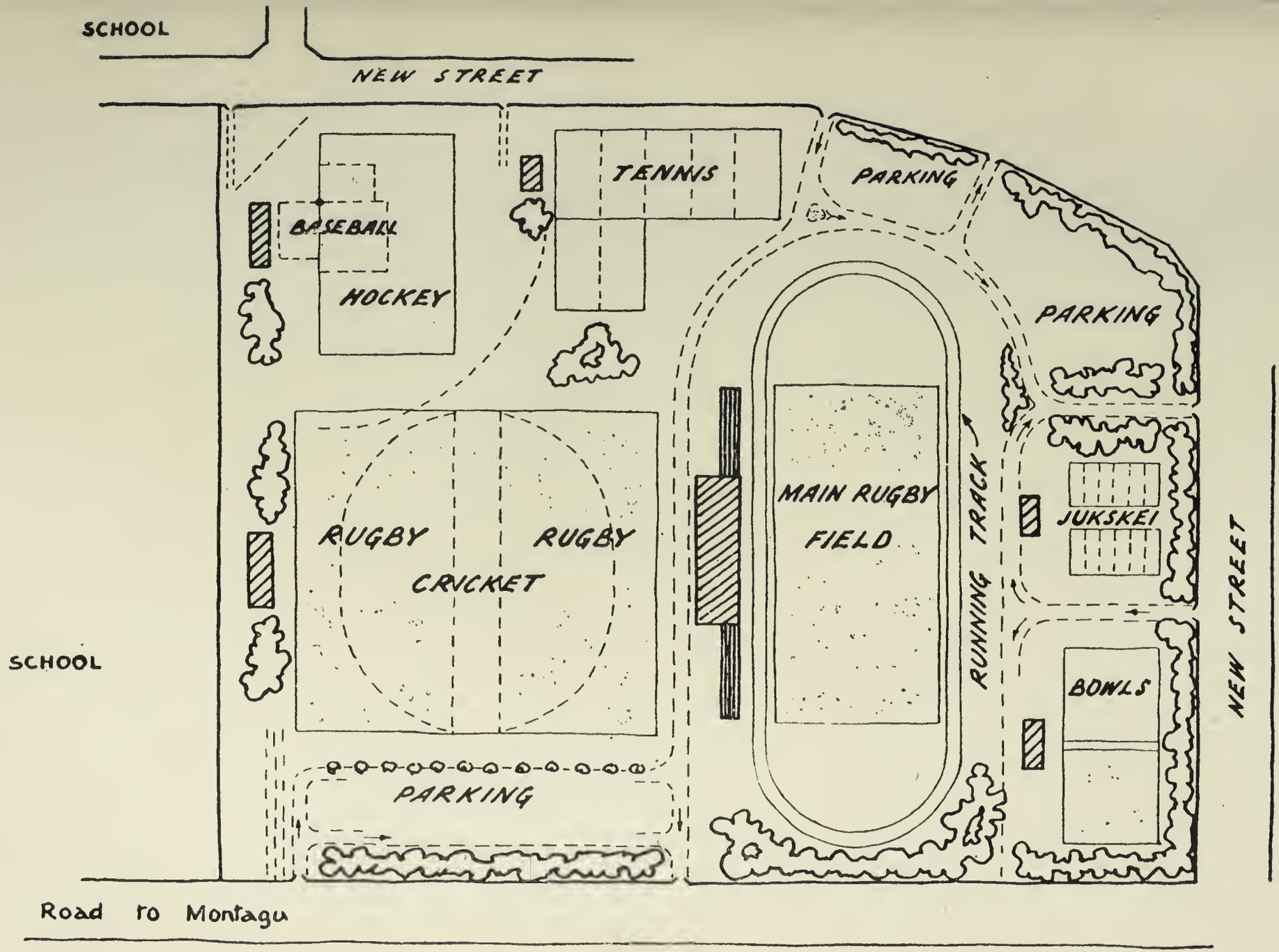

Fig. 46
PROPOSED SPORTS GROUNDS AT ROBERTSON

School sites may, to advantage, be planned adjoining or near to public open spaces and parks.

On no account should road frontage be saved by planning school sites at the backs of erven as done in some layouts. Such a situation ruins the outlook of a school and creates a gaol-like impression. It leads to endless friction between the school children and the abutting owners or tenants of the erven. It creates a place where abuses take place at night and where criminals may hide. In addition to the above disadvantages there is a loss to the neighbourhood of open land upon which dwellings may have had a pleasant outlook.

In the larger towns and cities a need has arisen for nursery schools. At present the provincial authorities have not a clear policy on this matter and these schools are left to private enterprise. In many cases they are not nursery schools but merely nurseries, but whatever they really are sites are required.

These schools cater for the age group 2—5 which is on the average about 10% of the population. At least 12 square feet of area is required per child and the size of site suggested is $\frac{1}{4}$ morgen. These sites should each be within $\frac{1}{4}$ mile distance of the homes of the children they are to serve. Adjoining a park or public open space is the best position for nursery school sites.

3. SPECIAL OPEN SPACES

In the planning of towns provision must be made for semi-private open spaces or special open spaces.

Not all of the various types of special open space will be needed in every town. For example only country towns serving a large district will need to provide an area for an agricultural show ground. Such sites are used only once a year or on a few other occasions but they should not be placed far from the town. It is usual for agricultural societies to control these show grounds. An area of 8—10 morgen should be sufficient for most towns.

Nearly all towns will need a golf course. 120 morgen is needed to provide for an 18 hole course and 60 morgen for a 9 hole course. If all the land cannot be used beneficially the areas allowed should be more, whereas if it can be intensively used a slightly smaller area may be sufficient.

This form of open space is usually controlled by a club and the land is leased to them by the local authority.

Certain towns may need an area set aside for a racecourse but this is usually provided outside of any township area.

Holiday resorts and towns through which tourist traffic passes in large numbers need camping sites. Such areas may be combined with a large park or other open space use.

Camping sites may prove to be a nuisance to permanent residents unless they are very carefully located. The areas required for them will vary greatly with the peculiar needs of each town.

Every new town that is planned should have a site where Dingaansday gatherings may take place. These grounds should have a large flat portion where the meetings may take place and where shelters may be erected. Surrounding or adjoining the meeting place there ought to be a well-wooded area where the people may picnic and rest in the shade between the meetings.

Dingaansday gathering sites may be combined with or situated in large parks, picnic grounds, or camping sites but the area where meetings take place must be set apart in order to enable the responsible committee to control same and ensure that outsiders do not cause a disturbance during gatherings.

The sites for Dingaansday gatherings need not be in a town but should not be too far off.

Chapter IX

PROCEDURE IN THE SUBMISSION AND PASSING OF TOWNSHIPS AND SMALL HOLDINGS

1. Townships
2. Agricultural Small Holdings and Small Farms

1. TOWNSHIPS

Generally

In all four provinces the same procedure is broadly followed in the establishment of townships. There is a body called the Townships Board in the Transvaal, Cape and Orange Free State. In Natal there is a similar body termed the Private Townships Board. The Surveyor-General is the Chairman of the Board in all the provinces except the Cape and Transvaal, each of which has a full-time Chairman.

Each Board investigates all proposals for new* townships submitted to the Administrator of the province in which it functions. It reports to the Administrator who, together with the Executive Committee, consider the report and express approval, disapproval or postponement of their decision. The Administrator then notifies of the decision.

Applications are in the first instance submitted to the Administrator through the Provincial Secretary direct or by way of a local authority depending on the province. The Administrator then refers any such applications to the Townships Board.

When an application for the approval of a township is submitted the consent of the bond holder must be obtained and submitted to the Board. All servitudes must either be respected or their cancellation obtained by the applicant.

The proposed conditions of establishment and conditions of title to be imposed on the various† erven must also be submitted to the Board.

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* Termed " Private Townships " in Natal.

† In the Cape and Natal the term " lot " is used, whereas on the Reef the term " stand " is often used.

Should any proposed township be on mining land or proclaimed land, application for the release of the surface for township purposes must be made to the Commissioner of Mines. Until this consent and the release have been obtained it is useless to proceed with the proposal or to submit same for the Administrator's approval.

If the land is intended for occupation by Natives the consent of the Minister of Native Affairs is required. In the Transvaal and Natal the consent of the Minister of Interior is required if the land is intended for Asiatic occupation.

After the township application has been granted the owner must submit a general plan within a period of 12 to 18 months depending on the province or within such time as the Administrator allows. A land surveyor then proceeds to peg out the township erven and prepare the general plan.

When the general plan and diagram are submitted to the Surveyor General all calculations must also be included. The general plan must show the dimensions, angles and areas of all erven as well as all co-ordinates.

When the general plan and calculations have been checked and the Surveyor General has approved of same he notifies the Administrator. A copy of the general plan and diagram together with the conditions of establishment and conditions of title must then be lodged with the Registrar of Deeds, who opens a register for the township.

In all provinces application forms, which require certain information, must be filled in when application is made. Certain particulars mentioned in these forms must be shown on the plan. The regulations framed under the various township ordinances should be referred to.

The plans submitted must show residential, business, special erven, open spaces, parks, school sites, widths of streets, contours and topographical features, such as vleis, rivers, dams, hills, rocky outcrops, excavations, graves, groups of trees, fences, huts, houses, kraals, railways, roads and tracks.

A key plan must be shown which indicates the position of the township in relation to the centre of the town and the nearest railway station. The streets of any adjoining townships must be shown in order to assist co-ordination.

Costs of publication notices, fees, travelling expenses and costs of the Board in connection with the inspection must be borne by the applicant. These costs vary in the different provinces. In the Transvaal a deposit of £30 is required exclusive of any fees payable. The deposit in the Cape may not exceed £50 and in Natal £20. In the Cape the Chairman of the Board determines the amount of the deposit.

The fees in the Transvaal are as follows :—

Up to 15 erven	£25
From 16 to 50 erven ..	£35
From 51 to 100 erven ..	£50
From 101 to 150 erven ..	£75
From 150 to 200 erven ..	£100
For every 100 or part thereof erven in excess of 200 ..	£25

To these fees are added the costs of notices and inspection.

The names of townships are approved by the Postal Authorities.

Although the procedure followed is broadly the same in all provinces there are many differences in details.

Transvaal (*Ordinance No.* 11 *of* 1931)

In this province township plans must be drawn to an approved natural scale not being smaller than 1 in 2,500. Scales of 1 in 2,000, 1 in 1,500, 1 in 1,250, 1 in 1,000 and 1 in 500 are also used depending on the area of the township. The scale of 1 in 2,500 is the one most commonly used. Contours are required at vertical intervals of 5ft.

Twenty-seven prints of the layout must be submitted when application is made. The whole of the twenty-seven prints need not be coloured.

Plans are required to show the minimum size of erven, street length, areas and percentage area of open spaces, percentage area of streets, etc. On receipt of the application from the Provincial Secretary the Secretary of the Board first reports the new application to the Board. Notice is inserted in the Provincial Gazette in both languages and in Afrikaans in an Afrikaans daily paper and in English in an English daily paper once a week for three consecutive weeks. Two months from the first appearance of the notice is given in which to lodge objections.

Copies of the plan are distributed to the members of the Board, the Rand Water Board, the Provincial Roads Department, the South African Railways, the Public Works Department, the School Board concerned, the local authority in whose area the land is situated, any local authorities within five miles of whose boundaries the proposed township is situated, the Electricity Supply Commission the Mines Department, the Department of Native Affairs etc.

Either the Townships Board or (more usually) a committee of this Board inspects the site of the proposed township. An enquiry is then held on or near to the site or in the local area of its situation. At this enquiry all persons or local authorities who have lodged objections within the period given for same in the notice, may state their case. The applicant is also heard and the remarks and requirements of the various bodies and departments are made known. It is usual for representatives from the Public Works Department, the Local Authority and the School Board to be present at such inspections and enquiries.

The Board requires to be satisfied as to water supply, electricity supply, sanitation, cemetery sites, disposal sites, public open spaces, parks, recreation grounds, grades of roads, location sites, business sites, sites for any other special purposes, as well as the design and need of the township. The total length of the roads or streets and their percentage of the township area, as well as the area of public open spaces and minimum size of erf are required.

School sites are normally required to be 2 morgen in area, but smaller sites are accepted in small townships. The standard for arriving at the number of sites required is one school site of 2 morgen per 300 erven.

For townships of less than 300 erven the area of the school site is determined from the following scale :—

(*a*) if there are less than 25 erven in a township no school site is required,

(*b*) if a township has more than 24 erven but less than 38, the minimum claim will be for one erf,

(*c*) if a township has more than 37 erven but less than 51, the minimum claim will be for 2 erven,

(*d*) if there are more than 51 erven in a township but less than 300, the minimum claim will be for 2 erven plus the percentage, as given in the following table :—

Average size of Residential erven in square feet	Percentage of residential erven
7,000 or less	13%
7,001 to 12,000	6%
12,001 to 17,000	4%
17,001 to 28,000	3%
28,001 or larger	2%

After the inspection of the site and the hearing of objections, the Committee reports to the Board, who then go into design, proposed conditions of establishment and conditions of title as well as all matters affecting the township. Often matters affecting local authorities such as servitudes or streets or matters affecting other bodies are left to the body concerned and the applicant to first see if agreement can be reached.

A set of model clauses for conditions of establishment and conditions of title has been drawn up and is used as a basis and guide for all new townships.

When satisfied on all matters, the Townships Board submits its recommendation to the Administrator. This may easily mean that some time may elapse before this stage is reached, for amendments are often required and sometimes complete re-design is asked for·

The Board is reluctant to agree to street widths of less than 50ft. but do agree to widths of 40ft. in certain cases. An area of 5,000 square feet may be regarded as the minimum that the Board will agree to in large towns and an area of 10,000 square feet for erven in country towns may be similarly considered.

Township owners are required to completely reticulate for water and electricity supplies before any erven are sold. All roads in the township must be formed, graded and kept trafficable until 40% of the erven abutting on any street have been built up, when the obligation for such street ceases.

The water and electricity reticulation systems become the property of the local authority when the erven are sold, but the owner must be refunded the cost of the electricity reticulation system.

Cape Province (*Ordinance No.* 33 *of* 1934)

Plans of townships submitted for approval in the Cape Province must be drawn to scales of 100 Cape feet to an inch or 1 in 1,250 but where the township is large and is on reasonably flat land a scale of 1 in 2,500 is permitted. See Notice No. 401 of 1935 framed under the Township Ordinance No. 33 of 1934.

Contours are to be shown on plans at 5ft. vertical intervals or at such lesser intervals as shall indicate the configuration of the site. The approximate areas of all special sites and public open spaces as well as the sizes of erven must be shown on the plan. The length of streets or roads is also required.

Ten prints of the plan are required by the Board. Copies are sent to the Educational Department, Mines Department, Public Works Department and the South African Railways.

On receipt of the application by the Administrator it is referred to the Townships Board. The Board forthwith publishes a notice, once a week for three consecutive weeks, in the Provincial Gazette and similarly in an English and an Afrikaans newspaper circulating in the district. This notice states that the application is open for inspection and that objections may be lodged before a given date, 10 days from the last appearance of the notice is given in which to lodge objections.

The Board is required to be satisfied as to water supply, sanitation, sites for cemeteries, deposit sites, public open spaces, parks, recreation grounds, commonage, erven for business and any other special purposes as well as grades of roads and the general design and need of the township.

School sites and their areas are determined by the Education Department.

The Board considers all objections together with the remarks of the local authority in whose area the township is located as well as the proposed conditions of establishment and conditions of title. A set of stock clauses for title conditions is worked to.

Street widths of 60ft. for main roads and at least 40ft. for residential roads are required by the Board except in special cases, such as access to two or three erven only, when a 30ft. width is permitted.

A minimum area of 6,000 square feet for erven intended for European occupation is called for.

Township owners are not required to reticulate with water or electricity when the township is in a municipal area. They must however clear, grade and roughly form all roads, whether the township is within or without a municipal area.

The owner may be required to grant land for government, local authority and educational purposes as well as to grant land to the local authority as an endowment.

Endowment to the local authority may be required in cash. The amount shall be a percentage, to be fixed by the Administrator, of the amount on which transfer duty is payable in respect of the sale of erven in the township. This percentage shall not exceed 15%.

Natal (*Ordinance No.* 10 *of* 1934)

Applications for the approval of private townships are made to the Administrator except in the case of Durban, Pietermaritzburg and Ladysmith. These three towns have full powers to control and approve townships in their own respective areas.

All proposed township plans must be prepared to a scale of not less than 1 in 1,250 if the area is less than 300 acres and 1 in 2,500 if greater than this. Contour lines must be shown at 5ft. vertical intervals, except where the maximum grade of the site is 1 in 10 or steeper. In the latter cases contours may be at 10ft. vertical intervals. (See Notice No. 152, 1940 framed under the Private Township and Town Planning Ordinance No. 10 of 1934.)

Altogether six or eight copies of the plans must be submitted to the Board with the application. Copies are not sent to all the members of the Board but are sent to any local authority in whose area the township is situated or is within three miles of its boundary and the Deputy Chief Health Officer of the Union and Department of Education. If any national road is involved, a copy is also sent to the National Road Board.

Copies are not sent to the Provincial Roads Engineer, South African Railways, Public Works Department, Native Affairs Department and Escom, but all these authorities inspect the township plans at the Board's offices.

On receipt of the application, proposed conditions of establishment and prints from the Administrator, the Secretary of the Board reports the new application to the chairman.

Notice is in due course inserted in the Provincial Gazette and a local newspaper once a week for three consecutive weeks and stating that objections may be lodged before a given date. Twenty-one days from the first appearance of the notice are given in which to lodge objections.

The site is inspected by a sub-committee of the Board and an enquiry held near the site when representations may be made by objectors.

The Board requires to be satisfied as to water supply, sanitation, sites for cemeteries, deposit sites, public open spaces, parks, recreation grounds, commonage, business and special uses as well as grades of road, general design of the private township and the need for same.

School sites are to be provided according to the requirements of the Education Department. The sizes range from 3 acres for an infant school up to 10 or 15 acres according to the size of the private township.

The total length of the roads or streets and their area as well as the areas of the public open spaces and the minimum size of erf are required.

After the inspection has taken place and objections and representations have been heard, the Board considers them together with the application. The proposed conditions of establishment and conditions of title are carefully gone into. A set of stock clauses for title conditions has been drawn up and is used as a basis for the conditions of all townships.

The Board is reluctant to agree to an erf size less than 10,890 square feet in extent or a size less than that required by local by-laws.

40ft. is the minimum street width permitted but widths of 50 to 100ft. may be required.

All roads shall be made trafficable before any erven are transferred. "Made trafficable" means cleared of trees, roots, boulders and obstructions as well as being formed and graded to final road levels. Drains and culverts must be provided where required and soft portions of roads must be gravelled to a depth of six inches.

Endowment may be paid in land or cash and is usually assessed at 8% of the sale value of erven. The Ordinance provides for a maximum of 10%.

Orange Free State (*Ordinance No.* 20 *of* 1947)

In the Free State no new township may be established within 20 miles of the boundaries of an existing town or approved township except with the special consent of the Provincial Council.

On receipt of an application for a township a notice is inserted in the Provincial Gazette as well as in an Afrikaans and an English newspaper, once a week for three consecutive weeks. Sixty days, commencing from the first appearance of the notice, are given in which objections and representations may be made.

Where a proposed township is outside the area of a municipality, a preliminary plan may be submitted first. On receipt of this and the application an enquiry is held by the Townships Board. Objections and representations are then heard on the principle of establishment. The Board next reports to the Administrator and the application together with the Board's report is laid before the Provincial Council for their decision.

When the principle of establishment has been decided the Board considers the application in detail. The proposed conditions of establishment and the conditions of title are considered as well as any objections and representations.

The procedure is simplified in cases where the application in respect of an extension to an existing township is from the local authority. No notice or advertisement is then required. A committee or the chairman of the Board inspects the site. If the extension is a minor one the chairman alone carries out the inspection.

Plans must be prepared to a suitable natural scale. Contours at vertical intervals of 10ft. may be permitted where the terrain is such that smaller intervals are not warranted. It is usual to show contours at 5ft. vertical intervals.

Twelve copies of the plans must be sent with the application. Copies are sent to all members of the Board in the case of new townships and also to the following authorities : Education Department, Public Works Department, South African Railways, Native Affairs Department and Union Public Health Department, etc.

The Board requires to be satisfied as to water supply, electricity supply, sanitation, sites for cemeteries, deposit sites, public open spaces, parks, recreation grounds, business and special uses as well as the grades of roads and the general design and need of the township.

The total length of streets, their percentage area of the total area, the area of the public open spaces and the minimum size of erven should be shown.

School sites are generally required to be 5 morgen in extent, although various sizes may be required if provision for primary and secondary schools is considered essential by the Education Department.

The Board is reluctant to agree to street widths of less than 60ft. or erven of an area less than 10,000 square feet.

Endowment is always required but the amount depends upon the nature of the obligations required of the applicant in regard to the construction and maintenance of streets and the provision of essential services.

AGRICULTURAL SMALL HOLDINGS AND SMALL FARMS

Transvaal

In the Transvaal, agricultural small holdings are established under the Agricultural Holdings (Transvaal) Registration Act, 1919, as amended by Act 19 of 1929 and Section 36 of Act 46 of 1937.

The applications and plans are considered by the Townships Board and the procedure of inspection and enquiry is similar to that for townships except that no notice is placed in the Provincial Gazette or the daily press. After consideration of the application, plans, representations and objections the Board reports to the Minister of

Lands who finally approves and issues the certificate, but he must act on the advice of the Board.

Holdings must be surveyed and a general plan prepared and approved by the Surveyor General in a similar manner as for townships. A register is also opened by the Register of Deeds.

Plans must be to a scale of not less than 1 in 5,000 and contours at vertical intervals of 10ft. must be shown on the plans. Topographical features on the site must be shown as for townships.

No holding may be less than one morgen in extent and every holding should have one morgen of arable land as part of its area. All plots are agricultural holdings but some may be given a special right to conduct certain forms of business necessary for the group of holdings.

School plots and plots for public purposes are usually required. Plots for government purposes may be required. No endowment is paid but roads must be made trafficable.

Access to plots must be provided by means of roads and the Board does not favour a width of less than 50ft. For main or important roads an 80ft. width may be required.

The Board also considers questions of sanitation, water supply, cemeteries and general design of the layout. Water supply is usually by means of boreholes, but septic tanks are not permitted where the domestic water is obtained from boreholes.

Land may also be subdivided into small farm portions of not less than 10 morgen in extent. Plans must be to a suitable scale and contours need not be shown. Access to the small farms is by means of rights-of-way.

Plans for small farm portions are submitted to the Surveyor. General for approval as is done with any other farm subdivisions-

The Provincial Powers Extension Act No. 10 of 1944 empowered the Provincial Council to make ordinances prohibiting or regulating the division of certain land, described in the Act, into portions of less than 25 morgen.

Cape Province and Natal

No small holdings act or ordinance exists in the Cape Province or Natal. Small farms may, however, be laid out either in the form of a township or as farm subdivisions.

Plans for farm subdivisions must be to a suitable scale, which depends on the size and number of the portions. No contours are required to be shown.

The Townships Board in the Cape Province is not favourably disposed to farm portions near a town which will be used rather for residential than agricultural purposes even if the size is 5 morgen or more.

Access to the various portions should be by means of excluded portions.

Applications for subdivision into small farm portions is made to the Surveyor-General as for any farm subdivisions. He may refer the application to the Board if he considers that there is an evasion of the Townships Ordinance.

Orange Free State

Small holdings of less than 25 morgen in extent may be laid out under the Small Holdings Ordinance No. 4 of 1934 (O.F.S.) and are subject to the consent of the Administrator.

Applications and plans are submitted to the Administrator.

Plans must be to a suitable scale and 1 in 5,000 is commonly used. The minimum size of plots allowed except in very special circumstances is 5 morgen.

Applications are referred by the Provincial Secretary to the chairman of the Townships Board, who is personally empowered under the Ordinance to make recommendations regarding a limited number of holdings. In more extensive layouts the chairman refers the application to the Board for inspection, enquiry and recommendation to the Administrator.

Provision is made in the Ordinance for the granting of sites for government, educational and communal purposes. Provision is also made for the payment of endowment of not less than 5% and not more than 20% of the land value.

All access roads must not be less than 50ft. in width and must be provided in the form of servitudes in favour of the general public.

APPENDIX

STUDY LAYOUT (1) DETAILS OF SERVICES.

	Amount per Erf	Cost per Unit	Cost per Erf	
			£ s. d.	£ s. d.
Roads—				
251,200 sq. yds. ..	371 sq. yds.	5/- per sq. yd.		22 15 0
Sewers—				
4″ Pipes 5,810 ft.	8·6 ft.	2/- per ft.	17 2	
6″ Pipes 22,690 ft.	33.5 ft.	3/3 per ft.	5 8 11	
8″ Pipes 760 ft.	1·1 ft.	5/6 per ft.	6 0	
Excavation—				
0′— 6′ 11,470 ft.	16·9 ft.	2/6 per ft.	2 2 3	
6′—10′ 15,300 ft.	22·6 ft.	3/6 per ft.	3 18 9	
10′—15′ 2,490 ft.	3·9 ft.	7/6 per ft.	1 9 4	
Manholes—				
1,044 ft.	1·5 ft.	£1 per ft.	1 10 0	
Manhole Covers—				
151	·22	£2 10/- each	11 1	
				16 3 6
Stormwater Drains—				
12″ 2,370 ft.	3·5 ft.	6/- per ft.	15 0	
15″ 3,560 ft.	5·3 ft.	7/- per ft.	1 17 2	
18″ 3,670 ft.	5·4 ft.	9/- per ft.	2 8 7	
21″ 1,190 ft.	1.75 ft.	10/- per ft.	17 6	
24″ 1,520 ft.	2·2 ft.	12/- per ft.	1 6 5	
27″ 950 ft.	1·4 ft.	14/- per ft.	19 7	
30″ 1,550 ft.	2·3 ft.	16/- per ft.	1 16 10	
33″ 1,550 ft.	2·3 ft.	18/- per ft.	2 1 5	
36″ 280 ft.	·4 ft.	20/- per ft.	8 0	
42″ 420 ft.	·6 ft.	25/- per ft.	15 0	
45″ 630 ft.	·9 ft.	27/6 per ft.	1 4 9	
Catchpits & Manholes—				
110	·16	£10 each	1 12 0	
				16 2 3
				£125 0 9
Water Reticulation—				
4″ Pipes 23,130 ft.	34·2 ft.	4/- per ft.	6 16 10	
2″ Pipes 10,990 ft.	16·2 ft.	2/4 per ft.	1 17 10	
				8 14 8
				£8 14 8
Elec. Reticulation—				
246 Spans	·363	£20		£7 5 2

STUDY LAYOUT (2) DETAILS OF SERVICES.

	Amount per Erf	Cost per Unit	Cost per Erf	
			£ s. d.	£ s. d.
Roads—				
249,744 sq. yds. ..	370 sq. yds.	5/- per sq. yd.		92 10 0
Sewers—				
4″ Pipes 5,740 ft.	8·5 ft.	2/- per ft.	17 0	
6″ Pipes 21,380 ft.	31·5 ft.	3/3 per ft.	5 2 4	
8″ Pipes 980 ft.	1·5 ft.	5/6 per ft.	8 3	
Excavation—				
0′— 6′ 16,160 ft.	23·9 ft.	2/6 per ft.	3 2 1	
6′—10′ 8,040 ft.	11·9 ft.	3/6 per ft.	2 1 7	
10′—15′ 4,000 ft.	5·9 ft.	7/6 per ft.	2 4 4	
Manholes—				
1,013 ft.	1·5 ft.	£1 per ft.	1 10 0	
Manhole Covers—				
139	·21	£2 10/- each	10 6	
				15 16 1
Stormwater Drains—				
12″ 2,650 ft.	3·9 ft.	6/- per ft.	1 3 5	
15″ 4,800 ft.	7·1 ft.	7/- per ft.	2 9 9	
18″ 3,800 ft.	5·6 ft.	9/- per ft.	2 10 5	
21″ 2,260 ft.	3·3 ft.	10/- per ft.	1 13 0	
27″ 2,400 ft.	3·6 ft.	14/- per ft.	2 10 5	
30″ 1,730 ft.	2·6 ft.	16/- per ft.	2 1 7	
33″ 1,350 ft.	2·0 ft.	18/- per ft.	1 16 0	
36″ 600 ft.	·9 ft.	20/- per ft.	18 0	
42″ 620 ft.	·9 ft.	25/- per ft.	1 2 6	
Catchpits & Manholes—				
116	·17	£10 each	1 14 0	
				17 19 1
				£126 5 2
Water Reticulation—				
4″ Pipes 25,920 ft.	38·4 ft.	4/- per ft.	7 13 7	
2″ Pipes 10,990 ft.	16·3 ft.	2/4 per ft.	1 18 0	
				9 7 11
				£9 11 7
Elec. Reticulation—				
264 Spans	·391	£20		£7 16 4

STUDY LAYOUT (3) DETAILS OF SERVICES.

	Amount per Erf	Cost per Unit	Cost per Erf £ s. d.	Cost per Erf £ s. d.
Roads—				
238,400 sq. yds. . .	374 sq. yds.	5/- per sq. yd.		93 10 0
Sewers—				
4″ Pipes 10,380 ft.	16·3 ft.	2/- per ft.	1 12 7	
6″ Pipes 18,855 ft.	29·6 ft.	3/3 per ft.	4 16 2	
8″ Pipes 892 ft.	1·4 ft.	5/6 per ft.	7 8	
Excavation—				
0′— 6′ 14,310 ft.	22·5 ft.	2/6 per ft.	2 16 3	
6′—10′ 12,450 ft.	19·5 ft.	3/6 per ft.	3 8 3	
10′—15′ 3,400 ft.	5·3 ft.	7/6 per ft.	1 19 9	
Manholes—				
1,067 ft.	1·7 ft.	£1 per ft.	1 14 0	
Manhole Covers—				
154	·25	£2 10/- each	12 6	
				17 7 2
Stormwater Drains—				
12″ 3,050 ft.	4.8 ft.	6/- per ft.	1 8 10	
15″ 1,700 ft.	2·66 ft.	7/- per ft.	18 8	
18″ 3,200 ft.	5·0 ft.	9/- per ft.	2 5 0	
21″ 3,050 ft.	6·33 ft.	10/- per ft.	3 3 4	
24″ 1,650 ft.	2·6 ft.	12/- per ft.	1 11 3	
27″ 1,650 ft.	2·6 ft.	14/- per ft.	1 16 5	
33″ 1,050 ft.	1·66 ft.	18/- per ft.	1 10 0	
36″ 150 ft.	·25 ft.	20/- per ft.	5 0	
42″ 1,750 ft.	2·75 ft.	25/- per ft.	3 8 9	
Catchpits & Manholes—				
100	·16	£10 each	1 12 0	
				17 19 3
				£128 16 5
Water Reticulation—				
4″ Pipes 21,060 ft.	31·5 ft.	4/- per ft.	6 6 0	
2″ Pipes 14,190 ft.	22·3 ft.	2/4 per ft.	2 12 0	
				8 18 0
				£8 18 0
Elec. Reticulation—				
252 Spans	·396	£20		£7 18 4

STUDY LAYOUT (4) DETAILS OF SERVICES.

	Amount per Erf	Cost per Unit	Cost per Erf	
			£ s. d.	£ s. d.
Roads—				
243,210 sq. yds. ..	382 sq. yds.	5/- per sq.yd.		95 10 0
Sewers—				
4″ Pipes 7,070 ft.	11·1 ft.	2/- per ft.	1 2 2	
6″ Pipes 21,490 ft.	33·6 ft.	3/3 per ft.	5 9 2	
8″ Pipes 400 ft.	·6 ft.	5/6 per ft.	3 3	
Excavation—				
0′— 6′ 8,780 ft.	13·8 ft.	2/6 per ft.	1 14 6	
6′—10′ 17,900 ft.	28·0 ft.	3/6 per ft.	4 18 0	
10′—15′ 2,270 ft.	3·6 ft.	7/6 per ft.	1 5 3	
Manholes—				
1,145 ft.	1·8 ft.	£1 per ft.	1 16 0	
Manhole Covers—				
151	·25	£2 10/- each	12 6	
				17 0 10
Stormwater Drains—				
12″ 1,850 ft.	2·9 ft.	6/- per ft.	17 5	
15″ 3,050 ft.	4·8 ft.	7/- per ft.	1 13 7	
18″ 3,330 ft.	5·2 ft.	9/- per ft.	2 6 10	
21″ 2,100 ft.	3·3 ft.	10/- per ft.	1 13 0	
24″ 500 ft.	·75 ft.	12/- per ft.	2 0	
27″ 1,300 ft.	2·0 ft.	14/- per ft.	1 8 0	
30″ 740 ft.	1·2 ft.	16/- per ft.	19 10	
42″ 2,120 ft.	3·3 ft.	25/- per ft.	4 2 6	
Catchpits & Manholes—				
108	·17	£10 each	1 14 0	
				15 4 0
				£127 15 0
Water Reticulation—				
4″ Pipes 21,500 ft.	33·6 ft.	4/- per ft.	6 14 6	
2″ Pipes 11,340 ft.	17·8 ft.	2/4 per ft.	2 1 6	
				8 16 0
				£8 16 0
Elec. Reticulation—				
224 Spans	·351	£20		£7 0 4

STUDY LAYOUT (5) DETAILS OF SERVICES.

	Amount per Erf	Cost per Unit	Cost per Erf £ s. d.	£ s. d.
Roads—				
238,709 sq. yds. ..	367 sq. yds.	5/- per sq. yd.		91 15 0
Sewers—				
4″ Pipes 6,570 ft.	10·1 ft.	2/- per ft.	1 0 2	
6″ Pipes 22,000 ft.	33·7 ft.	3/3 per ft.	5 9 6	
8″ Pipes 240 ft.	·4 ft.	5/6 per ft.	2 2	
Excavation—				
0′— 6′ 11,260 ft.	17·3 ft.	2/6 per ft.	2 2 9	
6′—10′ 14,490 ft.	22·3 ft.	3/6 per ft.	3 18 0	
10′—15′ 2,860 ft.	44·4 ft.	7/6 per ft.	1 13 0	
Manholes—				
904 ft.	1·3 ft.	£1 per ft.	1 6 0	
Manhole Covers—				
126	·19	£2 10/- each	10 0	
				16 1 7
Stormwater Drains—				
12″ 1,300 ft.	2·0 ft.	6/- per ft.	12 0	
15″ 2,470 ft.	3·8 ft.	7/- per ft.	1 6 7	
18″ 1,720 ft.	2·6 ft.	9/- per ft.	1 3 5	
21″ 3,180 ft.	4·9 ft.	10/- per ft.	2 9 0	
24″ 740 ft.	1·1 ft.	12/- per ft.	13 2	
27″ 1,180 ft.	1·8 ft.	14/- per ft.	1 5 2	
30″ 850 ft.	1·3 ft.	16/- per ft.	1 0 10	
33″ 1,460 ft.	2·2 ft.	18/- per ft.	1 19 7	
36″ 1,440 ft.	2·2 ft.	20/- per ft.	2 4 0	
42″ 490 ft.	·75 ft.	25/- per ft.	18 4	
Catchpits & Manholes—				
97	·15	£10 each	1 10 0	
				15 2 1
				£122 18 8
Water Reticulation—				
4″ Pipes 22,300 ft.	34·3 ft.	4/- per ft,	6 17 2	
2″ Pipes 11,620 ft.	17·9 ft.	2/4 per ft.	2 1 10	
				8 19 0
				£8 19 0
Elec. Reticulation—				
235 Spans	·361	£20		£7 4 4

STUDY LAYOUT (6) DETAILS OF SERVICES.

	Amount per Erf	Cost per Unit	Cost per Erf	
			£ s. d.	£ s. d.
Roads—				
259,714 sq. yds. . .	386 sq. yds.	5/- per sq. yd.		96 10 0
Sewers—				
4″ Pipes 6,410 ft.	9·5 ft.	2/- per ft.	19 0	
6″ Pipes 21,710 ft.	32·25 ft.	3/3 per ft.	5 4 10	
8″ Pipes 880 ft.	1·3 ft.	5/6 per ft.	7 4	
Excavation—				
0′— 6′ 5,000 ft.	7·4 ft.	2/6 per ft.	18 6	
6′—10′ 12,610 ft.	18·75 ft.	3/6 per ft.	3 5 8	
10′—15′ 11,390 ft.	16·9 ft.	7/6 per ft.	6 6 9	
Manholes—				
1,138 ft.	1·7 ft.	£1 per ft.	1 14 0	
Manhole Covers—				
142	·21	£2 10/- each	10 6	
				19 6 7
Stormwater Drains—				
12″ 1,960 ft.	2·9 ft.	6/- per ft.	17 3	
15″ 3,410 ft.	5·1 ft.	7/- per ft.	1 15 8	
18″ 2,090 ft.	3·1 ft.	9/- per ft.	1 7 11	
21″ 1,030 ft.	1·5 ft.	10/- per ft.	15 0	
24″ 760 ft.	1·1 ft.	12/- per ft.	13 2	
27″ 1,000 ft.	1·5 ft.	14/- per ft.	1 1 0	
30″ 500 ft.	·7 ft.	16/- per ft.	11 1	
33″ 2,400 ft.	3·6 ft.	18/- per ft.	3 4 10	
36″ 1,580 ft.	2·3 ft.	20/- per ft.	2 6 0	
42″ 380 ft.	·6 ft.	25/- per ft.	15 0	
Catchpits & Manholes—				
135	·2	£10 each	2 0 0	
				15 6 11
				£131 3 6
Water Reticulation—				
4″ Pipes 21,900 ft.	32·5 ft.	4/- per ft.	6 10 0	
2″ Pipes 10,990 ft.	16·33 ft.	2/4 per ft.	1 18 0	
				8 8 0
				£ 8 0
Elec. Reticulation—				
230 Spans	·342	£20		£6 16 10

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